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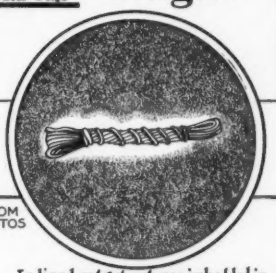

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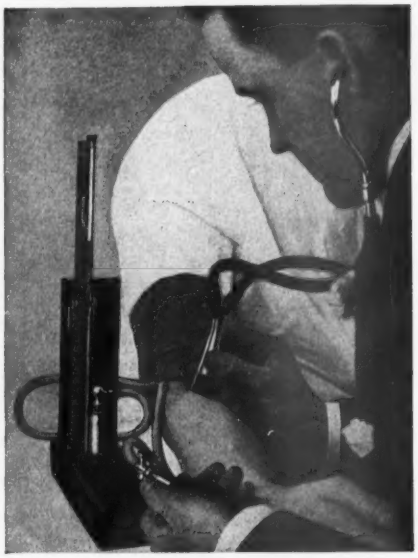

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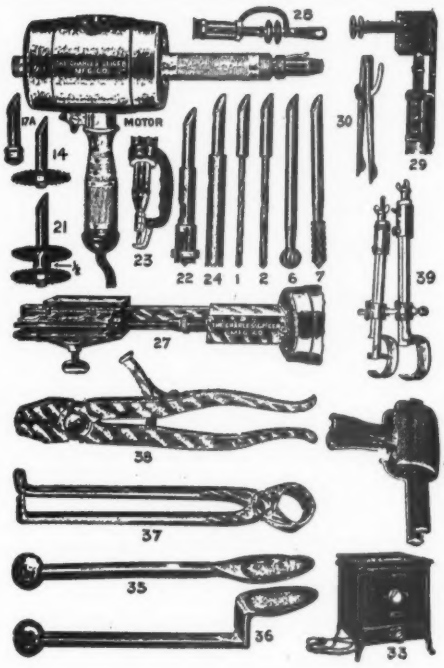

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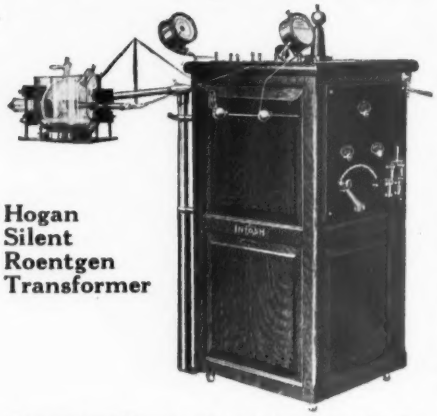

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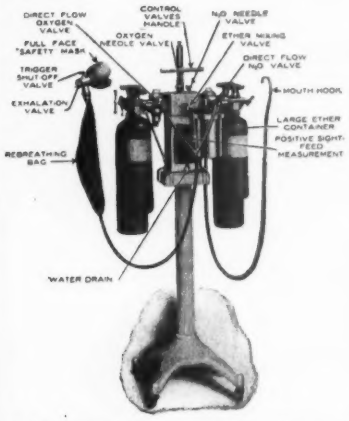

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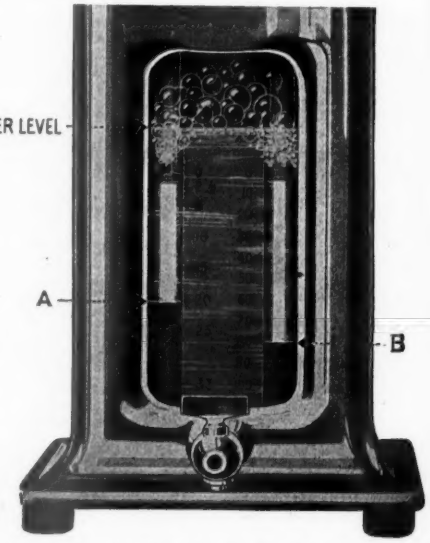

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VOLUME XXVII SEPTEMBER, 1918 NUMBER 3

ON INJURIES OF THE CERVICAL SPINE[1]

BY JOSEPH RANSOHOFF, M.D., F.A.C.S., F.R.C.S. (ENG.), CINCINNATI

A BROKEN neck has from time immemorial been potential of a speedy death, and if the fracture is of the right kind, recovery is impossible. As if the break in the cervical spine were insufficient, there quite often occurs with it a fracture of the base of the skull, to make the end doubly sure.

Within two years we have had in the Cincinnati General Hospital no less than three cases of fracture of the cervical spine with fracture of the base of the skull. In one of these there was also a fracture of the fifth lumbar vertebra. In each of these cases there was a great deal of shock, a condition which curiously enough is not ordinarily associated with cord injury. In one of these cases the temperature rose to 110° four hours before death, and 48 hours after the receipt of the injury.

Even in very high fractures, shock is often absent. In the case of a man who died on the fourth day after injury, there was found a fracture with dislocation of the axis. Although this man lived nearly four days, there was no shock, and notwithstanding the extensive derangement in the atlas there could have been only a partial cord disintegration.

The X-ray findings of fracture dislocations of the cervical spine with extensive disorganization of the cord are often disappointing, since they fail to reveal a degree of derangement of the column commensurate with the cord injury. For example in the case of A-4115 (Sheridan, Fig. 1), where death resulted after a subtotal paraplegia, the roentgenogram must be carefully studied before the break in the anterior lower margin of the fifth cervical body can be seen. There is no displacement. There was no weakness in the upper arm and no loss of sensation. There was marked weakness of the flexors and extensors of fingers and hand. The line of demarcation began at the third intercostal space, below which there was complete anæsthesia. Below this line there was flaccid paralysis and loss of deep reflexes. There was extreme arteriosclerosis. Sloughs formed on the buttocks and heels in a few days, but the patient lived seventeen days.

The case of B-7671 to be shown later further illustrates this point. A fine abnormal line between the transverse processes indicates where the dislocation had been. Except for some control over the deltoids there is a complete flaccid paraplegia. Exitus occurred 60 hours after injury was sustained.

This discrepancy between the roentgenographic findings and the cord changes are doubtless due to the fact that after the accident, either spontaneously or by the handling of the patient, a reposition of the parts takes place to something like their normal relations. Particularly is this true of the cases in which luxation plays a great rôle. While Chipault opposes this view of spontaneous replacement, Thoburn believes that in the cervical region particularly, reposition is

[1]Read before the Southern Surgical Association, St. Augustus, December 11-13, 1917.

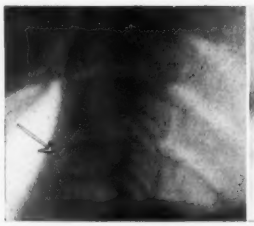

Fig. 1. (A–4115.)

Fig. 2. (Townsend.)

twice as common as is the permanent displacement. Our study of the roentgenographic findings, as we have seen, supports the contention of the English surgeon, and brings into the limelight the futility of interfering for deformities of the column alone, since the spontaneous relief of the latter, or that following manipulation, fails in so many instances favorably to influence the damaged medulla.

There were altogether 14 subcutaneous injuries to the cervical spine, of which 6 died. The complications in the fatal cases were fractures of the base of the skull, as already alluded to, or other internal injuries. Eight of the cases recovered and of these 6 presented neither cord nor nerve root symptoms of any kind. Two of the cases presented cord or cord and root symptoms. In addition to these there were two cord lesions from penetrating wounds, one of which died.

In most of our fatal cases the injury was to one of the lower cervical vertebræ, the place of election where the more movable portion joins the more fixed segment at its junction with the upper dorsal. One exception was in a case of fracture of the third vertebra. The other was a fracture dislocation which was admitted to the neurologic service, while

Fig. 3. (L. J.)

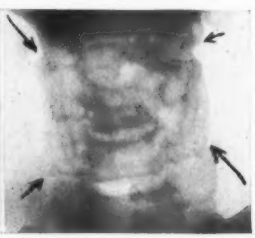

Fig. 4. (L. J.)

Fig. 5. (A–4146.)

Fig. 6. (A–2614.)

in a postepileptic mania. In an attempt to escape from the police he jumped from a window and sustained his injury. A satisfactory neurologic examination could not be made, since the patient was deeply comatose. The pupillary reaction was sluggish, the left pupil being the larger. Both arms and hands were moved without intent, and both legs, although paralyzed, responded somewhat to plantar irritation (Townsend, Fig. 2). The patient died within 72 hours, in deep coma.

Although the roentgenogram failed to reveal any injury to the skull, it is certain that death was due to a cerebral lesion. The roentgenogram shows a fracture of the odontoid process, with extensive comminution of the atlas.

In none of the fatal cases was an operation performed. In withholding from surgical interference, my colleagues and I evidently incline to heed the dictum of Horsley, to wit: "If the lesion is acute and in the cervical region, then certainly wait. As regards the dorsal region, better to wait a little. As regards the lumbar region, I do not think you want to wait to operate."

In a report from the Massachusetts General Hospital, by Hartwell, from 133 fractures of the spine, 40 patients were subjected to operation, 38 to laminectomy and 2 to an attempt to remove the deformity by manipulation. Taken as a whole, the result of expectant treatment in these cases equal those obtained by the operative treatment, and the results of laminectomy do not justify an argument in favor of operation, but rather serve as a warning against radical surgical treatment. Indeed there are some cases in

Fig. 7. (B–2544.)

Fig. 7. (B–2544.)

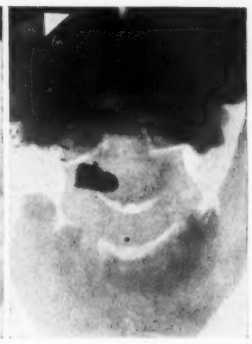

Fig. 8.

which an operation seems positively indicated, and in which, if performed, would be held responsible for recovery, if it took place. But such cases seem quite as often to recover without an operation.

The following case observed in private practice 23 years ago illustrates a complete recovery after more than a year, from what appeared to be a severe transverse lesion of the cord in the fifth cervical segment.

L. J., age 27, on November 24, 1895, while diving struck his head on the concrete bottom of a pool, in shallow water. He remembers floating to the top of the water, but could not lift his head out of the water. He did not lose consciousness and felt that he might drown before any one discovered him. Assistance came however. It was after he was brought home that he felt that he was completely paralyzed from the shoulder down and that the paralysis was not complete from the start. An examination made by Dr. Maury showed a fracture of the fifth and sixth cervical vertebræ. He was treated by Dr. Maury with a plaster cast and head extension. When this man was seen by me, 9 months after the injury, the condition was practically unchanged. After the year the paralysis gradually improved and now, 23 years after the accident, there is slight weakness of the arms in lifting and some of the muscles of the shoulders have slightly atrophied. The roentgenograms which were recently taken by W. S. Lawrence of Memphis (Figs. 3 and 4), show that there is an almost complete coalescence of the fourth, fifth and sixth vertebræ.

In this connection, the case of F. M., age 20, is also interesting. Unfortunately the roentgenograms cannot be found.

On the day before admission the patient fell down some steps and was rendered unconscious. For a short time after gaining consciousness she was irrational and confused. There was localized tenderness over the fifth and sixth cervical spines and crepitus could be easily obtained. There was paralysis of both arms, below the shoulder, with almost complete paralysis of the triceps and extensor muscles of forearms and fingers on both sides. A great deal of pain is complained of in the arms, but not well localized. Touch sensation is entirely absent over the dorsum of both hands, and the extensor surfaces of the forearms, and is much impaired over the left arm to the shoulder girdle. Pain sensation over the dorsum of the hand and the extensor surfaces of the forearms is entirely abolished. Pain sense is also diminished over the flexor surfaces. There is paresis of both legs, more marked in the left. The dorsal extensors of the foot seem chiefly affected. There is urinary and fæcal incontinence.

The neurologic diagnosis read: "Destruction of rootlets both anterior and posterior, coming chiefly from the sixth cervical segment, resulting in almost complete paralysis of the triceps, extensors of the hand and fingers, the major pectoralis on the right and left side. Also a zone of sensory destruction covering the back of the hand and forearm."

From the involvement of the lower extremities and the loss of functions of vesical and anal sphincters, an incomplete cord lesion was surely present. When this patient was discharged from the hospital within two months, she had entirely recovered, except for a paralysis of the extensor muscles of the fourth and fifth fingers of the left hand.

Another case with even more serious cord lesion that quickly recovered without operation was that of Spencer Lynn, (Fig. 5, A-4146, age 57).

Falling down stairs he sustained a fracture of the spinous processes of the third, fourth, and sixth cervical vertebræ. Pain sensation in the upper extremities was normal; absent in the lower. There was muscular paralysis of lower extremities to the hips, patellar reflexes much exaggerated, ankle-

Fig. 9. (A–7521.)

Fig. 10. (B–7671.)

Fig. 10. (B–7671.)

clonus, plantar reflexes normal. There was no priapism, incontinence of urine or of fæces.

The lesion here was evidently not a complete transverse one. This patient left the house two months after admission, walking without assistance, and with complete control of his sphincters.

In these cases which recovered without operation, the recovery would have been attributed to the operation, had one been performed.

The mortality of our cervical spine injuries is less than 50 per cent. This is in marked contrast with those recorded only a few years ago. Chipault had 22 cases, with 21 deaths, and 1 improvement; Bergman, while at St. Petersburg, 16 cases with 16 deaths; Guy's Hospital, 36 cases with 36 deaths; and Frank Hamilton, 18 cases with 18 deaths. The cause of this discrepancy is, of course, the graphic manner in which injuries to the spine are now displayed, white on black. Our immediate forbears in surgery based the diagnosis of spinal lesions almost wholly on the narrowing of the spinal canal, which they produced, and the damage to the cord consequent thereon. The localized pressure tenderness, muscular rigidity, restricted movement and irregular alignment of the spinous processes, were of necessity only potential factors toward diagnostic probabilities. Fracture of the spinous processes were thus recognized, but these are as a rule not limited to the spines, but involve the bodies as well. The roentgenograms of cases A-2614 (Lang, Fig. 6) and B-2544 (Hampton, Fig. 7), show this admirably. As to neurologic findings, both cases were negative. They did not make the diagnosis certain. As we have seen, the outcome in the class of cases formerly regarded as fractures of the spine is no less or little less fatal today than it always has been. It is self-evident that we now recognize with greater ease injuries to the vertebral column.

The taking of plates through the open mouth as first advocated by Griffiths is a valuable addition to X-ray study of the cervical spine. Figure 8 shows a bullet located by a roentgenogram taken through the mouth. Although it seems to be lodged against the spine, it is behind the spine and has not touched it. The track of the bullet can easily be followed from the point of entrance in the parotid region to its final lodgment behind the spine.

The frequency with which the cervical spine is injured without cord involvement is illustrated by the number of cases recorded in less than two years in the Cincinnati General Hospital. The experiences in the Cincinnati General Hospital, is, of course, not unique. Hartwell (1), during 6 months' service in the male surgical division of the out patient department of the Massachusetts General Hospital, reports 10 patients who sought relief for pain in the back and who were found to have a fracture of the spine, and one patient with spinal fracture who was treated in the orthopedic division. Not one of the cases had at any time had any motor or sensory paralysis or sphincteric disturbance. Of the series, 8 cases were compression fractures, one was a fracture dislocation and 2 were fractures of the transverse processes of the lumbar vertebræ.

Curiously enough the fatal cases in cervical fractures are mostly in the lower four vertebræ, and are compression fractures from

Fig. 11. (B-8641.)

Fig. 11. (B-8641.)

Fig. 12. (B-7936.)

Fig. 13. (B-6873.)

indirect trauma. We saw no cases of tear of the intervertebral discs, which occurs in less than 1 per cent of the cases.

Only one case could be positively diagnosticated as a direct fracture (A-7521 Weaver, Fig. 9), and this was brought about by a blow with a heavy wooden club.

The fracture was through the lamina of the second cervical vertebra, with considerable forward displacement of the body. The lateral movements were very much limited and caused a great deal of pain, and although there was considerable dysphagia there were no cord symptoms whatever. When one considers the damage done to the vertebra and the amount of displacement and narrowing of the canal, it seems a marvel that the cord escaped fatal damage. The same degree of overlapping from trauma in the lower cervical vertebræ would almost certainly have produced fatal infringement on the lumen of the canal and crushed the cord.

In one other case there was a suspicion of direct injury.

The patient was struck by a wagon, but there was nothing to indicate where the injury was inflicted (B-7671, Surratt, Fig. 10) except a slight abrasion over the coccyx. Curiously enough this was the only case of the entire series of a pure dislocation without fracture. The body of the fifth vertebra on the stereoscopic plate appears dislocated on the sixth, but if the pictures were presented without any accompanying history, it would be improbable, in my judgment, that any one would make the diagnosis of dislocation. A white line on one side indicates a diastasis of the articular processes. Nevertheless, in this case the Thoburn syndrome was complete and priapism was present. The patient died from complete transverse lesion 72 hours after admission.

It may be observed that priapism was present in all but one of our fatal cases. It is almost always present when there is a complete cord disorganization, and is therefore a most ominous sign.

In all of our cases, with one exception, the neurologic evidences of complete cord injury were synchronous with the injury itself. This is a rule to which there are very few exceptions. Thus, of 67 patients from the Massachusetts General Hospital, who had signs of cord lesions, in 66 the onset of paralysis was immediate, and in only one was it gradual. In this connection the case of L. Johnson (B-8641, Fig. 11) of our series, is of interest.

This was a colored man, who received a stab wound of the neck, on a level with the fifth cervical vertebra. He walked into the hospital from the ambulance. A hæmatoma the size of an egg, containing a clot was cleaned out in the receiving ward, and the wound sutured. When the patient was asked to get up from the operating table after the sutures were placed, it was found that he could not get up, and on examination a complete paraplegia from the shoulders down was discovered. He was unable to use either leg. The knee-jerks were normal. Evidently the paralysis was the result of a hæmorrhage, and for this reason a laminectomy was determined upon. The roentgenogram showed a fracture of the spinous process of the fifth and one of the body of the sixth, without displacement. It seems remarkable that the knife blade could have been withdrawn intact, and that the cord was not cut. As happens occasionally in laminectomy in the cervical region, respiration was interfered with, and notwithstanding the establishment of artificial respiration, the patient died on the operating table, before the membranes could be exposed. An autopsy could not be obtained.

In the treatment of fractures, dislocations and fracture dislocations of the cervical spine, we have not only refrained from open

Fig. 14. Dislocation of fourth cervical vertebra.

operation, but likewise from manipulation of a more or less violent nature.

In a recent article, Stern speaks of 3 cases in which osteopaths and chiropractors have fractured the spine by their violence. We have managed in these cases to get along with suspension and the application of plaster casts of the chest, with head attachments. The end-result even if a reduction of the fracture is not accomplished has been eminently satisfactory in all of these cases, so far as we have been enabled to follow them. In the cervical spine, limitation of motion in any one joint, by reason of fracture or dislocation, is easily made negligible by other joints functuating in its place. These patients have thus far not suffered such inconveniences in any instance as to necessitate operative interference for its relief. That does not mean that cord or nerve root symptoms may not develop at a later period. The "sufficient unto the day" adage may be applicable here.

In this connection I am, of course, conscious of the very excellent work of Walton, emphasized by Mixter and Osgood, in the method of reducing unilateral luxations in the cervical region. Two very interesting cases of dislocation reduced by manipulation are reported by Major Speed in the December number of the *Annals of Surgery*. In the pure dislocations there can be no question but that an effort should be made at reduction by the Walton method, but in our series there has not been one that has not been quickly fatal from cord lesion. Since all the non-fatal cases were fracture cases primarily, the slower method has been followed.

The case of B-7936 (Nevin, Fig. 12), without any cord or nerve symptoms seems to be one of pure dislocation backward of the seventh cervical vertebra, but a careful study of the plate shows a slight fracture of the body.

From a medico-legal viewpoint these minor injuries of the cervical spine to a less extent, of course, than those of the lumbar region, are of major importance. No post-traumatic pain anywhere in the back should stamp the complainant as a malingerer until repeated examinations with the X-ray have proved negative.

The most interesting of the injuries in the cervical region was a shot wound of the neck.

The patient (B-6873, La Force, Fig. 13), a strong colored man, age 43, was admitted to the hospital on September 21, 1917. On the right side of the neck, on a level with the cricoid cartilage was the wound of entrance. The hæmorrhage from it was very slight. The patient complained chiefly of pain in the right arm and tingling and pricking sensation. The patient was able to move both arms and legs.

Neurological examination by Dr. Hoppe. The left eye is evidently more prominent than the right. The palprebral fissure is wider on the left side. The right pupil is very much smaller than the left, and reacts slightly to light. There is no loss of sensation in the distribution of the fifth nerve. Sensation in the leg is normal. There is no zone of hyperæsthesia. The muscle power of right arm is diminished as far as the grasp of the hand is concerned. The motor power of the triceps and biceps is normal. The deep reflexes in the upper extremities are slightly diminished on the right side as compared with left. The sensations of right arm in all qualities are normal. The sensation of the trunk is normal. The hypogastric reflex is absent on the right side but present on the left. The cremasteric reflex is absent on the right side; normal on the left. The motor power of the right leg is diminished as compared with the left. The patellar reflex on right side is slightly diminished as compared with left and rapidly exhausted. There are no plantar reflexes on the right side; normal on the left. There is no disturbance of sensation in either leg.

Stereoscopic X-ray plates showed the presence of a bullet which has apparently lodged against the interspace between the seventh cervical and first dorsal vertebræ, just to the right of the midline.

As the patient failed to improve after nearly 3 weeks, an operation was determined upon. The dissection followed a triangular trapdoor incision along the clavicle and the median line. The sternocleidomastoid was divided and the scalene muscle

with phrenic nerve was thoroughly exposed. The carotid sheath was drawn to one side and the sympathetic exposed and found intact. It was hoped by the exposure of the lateral processes and bodies of the lower cervical vertebræ that the bullet might be reached from above. Unfortunately this was not accomplished, and the bullet still is where it originally lodged. The very large wound healed without any wound complication. Whether or not, probably not, the operation had anything to do with the subsequent history, it is difficult to state, but at any rate this patient, almost from the time of the operation began to improve, so that when he left the hospital on November 8, 5 weeks after the operation, the pupils were of equal size, there was a slight difference still in the palprebal fissures, the muscular power in both arm and leg had been entirely restored.

The case is interesting from a number of viewpoints. This bullet did not penetrate the canal, produced no recognizable fracture and still caused by contusion a lesion in the cord, nicely limited to the pyramidal tract and the grey matter underneath, distinctly recognizable by characteristic symptoms. With the cervical sympathetic cord intact there must have been a contusion of the gray matter of the ciliospinal center, to account for the enophthalmos, the contracted pupil and the slight palprebral ptosis. This syndrome is characteristic of injuries of the sympathetic.

It is interesting here to note that the first shot wound of the cervical sympathetic in this country was described by Mitchell, Moorehouse, and Keen. In this instance there was in addition to the eye and lid symptoms hyperæmia of the face on exertion, with pain in the eye and light flashes. As the latter symptoms were absent in our case and as the sympathetic cord was intact, it seems to corroborate Kraus' contention that lesions of the cord are apt to be followed by the vasomotor symptoms named, and that in lesions of the spinal cord proper the symptoms are limited to the pupil and the eyelids. Those interested in the bibliography of this subject will find a complete résumé in *Die Neurologie des Auges*, by Wilbrand and Saenger.

Our judgment in delaying operation in this case was sustained by the most extensive report on shot wounds of the spine during the present war, in a communication from von Eiselsberg, who based his view on an experience of 35 cases. He recommended, in contradistinction of course to all brain injuries, that it is best to wait 4 or 5 weeks until the condition has become stationary before laminectomy is attempted.

NOTE.—Since the above article was put into type, a case of forward dislocation of the fourth cervical vertebra was admitted to the Second Surgical Service of the Cincinnati General Hospital. There were motor root symptoms involving both upper extremities but no paraplegia. The roentgenogram (Fig. 14) shows no evidence of a gross fracture, although by the tearing off of the anterior common ligament small spiculæ of bone were evidently wrenched from the vertebral body. This condition I imagine is not very uncommon, although it has been demonstrated in very few, if any, roentgenograms.

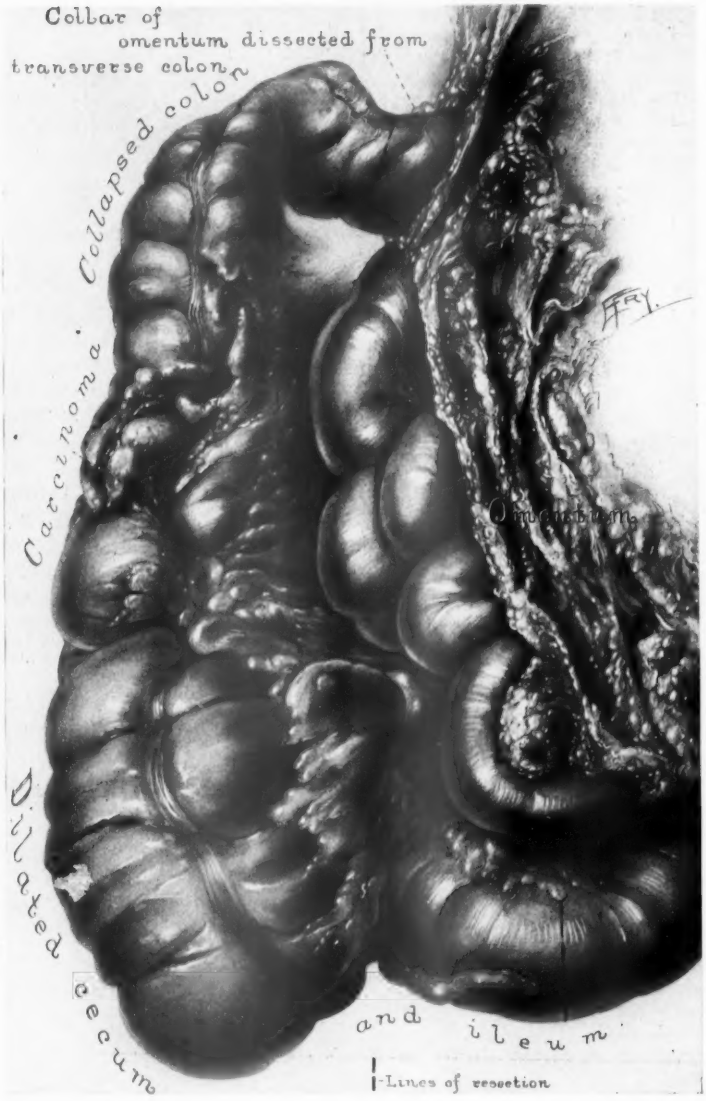

Fig. 1. Carcinoma of the ascending colon with dilated cæcum, dilated ileum, and contracted colon. Cuff of omentum dissected back, preliminary to resection.

(The Utility of End-to-End Anastomosis between Small and Large Intestine.—D. C. Balfour.)

THE UTILITY OF END-TO-END ANASTOMOSIS BETWEEN SMALL AND LARGE INTESTINE[1]

By D. C. BALFOUR, M.D., F.A.C.S., Rochester, Minnesota

THE restoration of the continuity of the small and large intestine following resection of the ileocolic coil is not the least important step in the operation. The exploitation of colonic resection for intestinal stasis has at least resulted in demonstrating the disadvantages of lateral anastomosis between the small and large intestine, and in the rather general adoption of end-to-side union. The latter method has no seriously objectionable features, but it involves two steps which are essentially additional, namely, the closure and inversion of the end of the large bowel and the formation of a separate opening in it for the implantation of the end of the small intestine. Axial union in any part of the intestinal tract is manifestly superior to all other methods, provided the operation can be done with safety, with the preservation of good function, and with the avoidance of late complications.

Recently Lockhart-Mummery has exposed some of the fallacies in the attitude toward axial union of the large intestine, showing that the relatively high mortality and morbidity from leakage are not due to inherent faults in the operation, and has described a method by which end-to-end anastomosis of the colon can be done with safety.

A more or less analogous situation exists in regard to end-to-end anastomosis of small and large intestine. It is quite evident that axial union between ileum and colon is given little or no consideration in the literature and, in so far as we are aware, the procedure is not utilized to any extent among surgeons in this country. Our experience has shown that end-to-end anastomosis of ileum and colon can often be easily and safely performed, which leads us to believe that the general attitude toward the operation is unwarranted. It is for this reason that I bring the method to your attention.

It should first be said that we have thus far recognized the apparent limitation of axial union to those cases in which there is a dilatation of the small bowel, due to a chronic obstruction from some well defined pathologic condition such as cancer (Fig. 1), or hypertrophic tuberculosis. Under such circumstances, the method has been exceedingly satisfactory. Resections of the ileocolic coil for conditions other than those associated with such definite pathologic processes are relatively rare in our Clinic, but when these other indications do arise, and the ileum is small, there seems to be no reason for abandoning the end-to-side anastomosis. At the same time, axial union has been so satisfactory in the group of cases in which the caliber of the small intestine more or less approximates that of the large intestine, it is quite possible that, by the employment of technical procedures (those of C. H. Mayo, for example) to increase the caliber of the smaller segment by cutting the bowel end obliquely without sacrificing its lumen or splitting the bowel opposite its mesentery, the scope of axial union may be extended to include cases in which little or no dilatation of the small intestine has occurred (Fig. 2B).

In carrying out end-to-end anastomosis between ileum and colon by suture, we have followed in general the method used by Lockhart-Mummery in axial union of the large intestine, the anastomosis being made in the following manner: The resection having been completed, the two stumps of the intestine are isolated by protective gauze pads, rubber-covered clamps are placed on each segment of bowel 2 or 3 inches from the end, the clamps at the extremity of the intestine are removed, and by repeated swabbing, both ends are thoroughly cleaned out. The ends of the intestine are now approximated by two traction-sutures, each of which is placed about half way between the anterior and mesenteric borders (Fig. 2A). They serve a most important purpose in maintaining a correct alignment, and in preventing

[1] Presented before the Southern Surgical Association, St. Augustine, Florida, December 11–13, 1917.

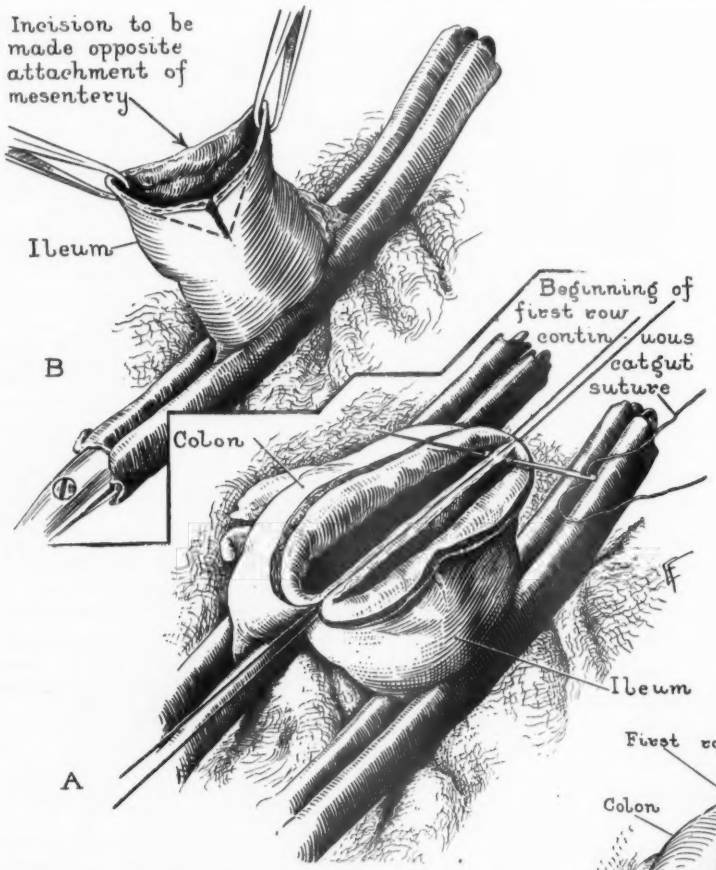

Fig. 2. *A*. Ileum and colon aligned and posterior row of sutures begun. *B*. Method of increasing caliber of ileum when not of sufficient size for direct anastomosis.

untoward narrowing of the anastomosis during suturing. Redundant mucous membrane is trimmed away with scissors until all coats of the bowel are flush with one another. The union of the segments is then accomplished by a continuous suture of chromic catgut. This suture begins laterally from the mucous side, including all the coats of the intestine, first uniting the posterior walls (the stitching being greatly aided by traction on the sutures orig nally placed) and continuing anteriorly around the circumference of the bowel, by the C. H. Mayo method, until the starting point is reached

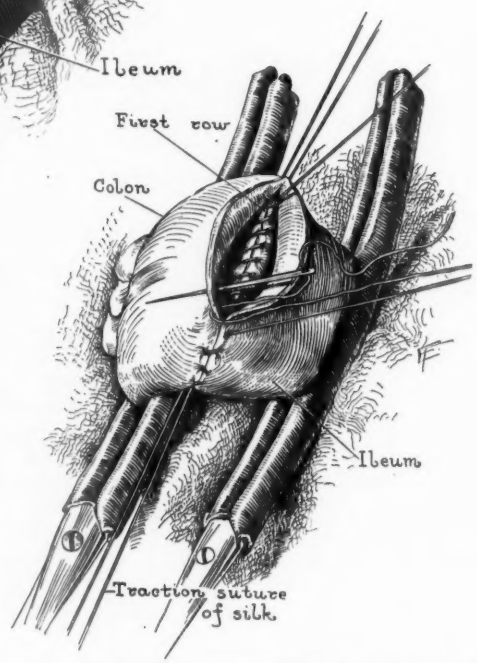

Fig. 3. The posterior suture completed and the anterior suture begun.

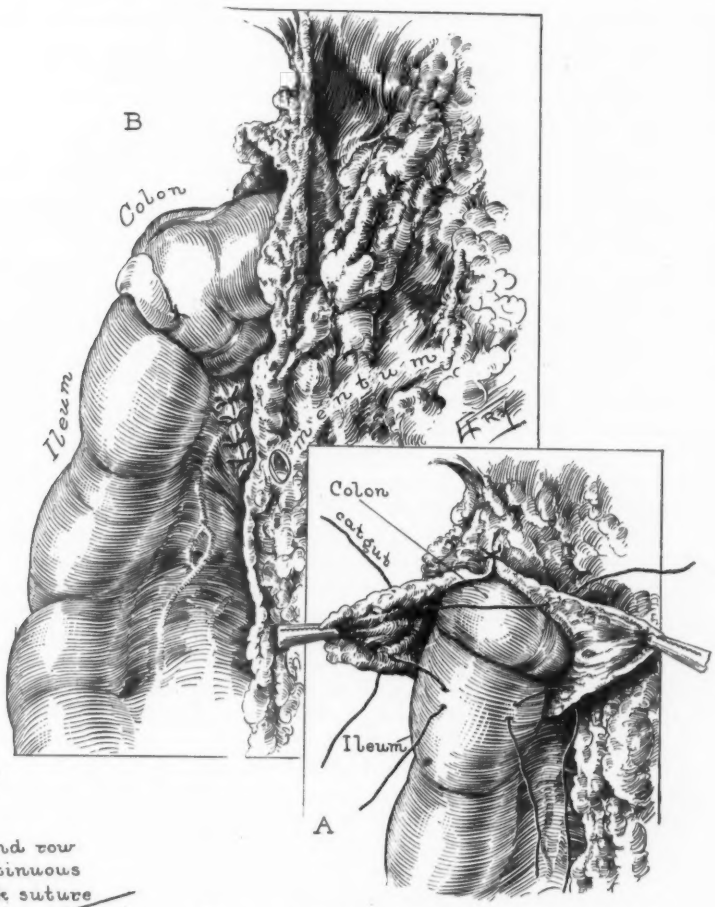

Fig. 5. *A*. Anastomosis completed and omental cuff prepared for fixation over suture line. *B*. Anastomosis completed and protected by fat tag, when omentum is not available.

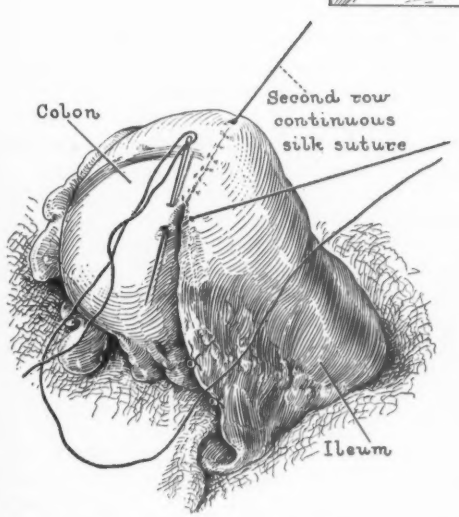

Fig. 4. Second suture of silk completing anastomosis anteriorly.

(Fig. 3). Two points deserve emphasis in connection with this suture: first, the stitches should be taken close enough to the cut-edge of the bowel so that the circulation will not be impaired, and second, that no catgut should be left exposed. A careful cleansing of gloves and instruments, and the anastomosis should now be made. A reinforcing musculoperitoneal suture of fine silk is placed around the anastomosis (Fig. 4), the two borders of mesentery are brought in apposition by catgut sutures, and finally the

anastomosis is protected by available omentum, or fat tags (Fig. 5). This protection may be most satisfactorily made by utilizing a collar of omentum (which can be stripped back before the intestine is resected Fig. 1), to surround the anastomosis very much as the intestine itself is used to protect the suture-line in the tube method of anastomosis. The entire field is now cleansed, gloves and instruments are changed, and the wound closed without drainage. Drainage predisposes to fistula, and should be omitted unless exceptional circumstances demand it.

The results obtained by end-to-end anastomosis between ileum and colon conducted in this manner, have been excellent, and having proved the safety of the method, its obvious simplicity is sufficient for its recommendation. We believe that if the operation is carried out with strict attention to every detail, the utility of axial union of small and large intestine will be quite apparent.

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THE ETIOLOGY OF URETERAL CALCULUS[1]

By GUY L. HUNNER, M.D., F.A.C.S., Baltimore
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FOR the past two years I have been particularly interested in the subject of ureteral stricture and I wish to report further experience in the work, because I am almost daily learning some new feature about it and becoming more impressed with its importance. I am simply amazed that we have all been overlooking this lesion so long and so thoroughly as we have. As patient after patient suffering with ureteral stricture and its effects, consults me, I ask myself what we have been doing with these patients in the past.

Up to November, 1915, I had recognized 50 cases as suffering with ureteral stricture. At our White Sulphur Springs meeting in December, 1916, I discussed 92 cases, 42 of them having occurred within the year after looking up the records of my original 50 cases and getting especially interested in the subject.

In this past year I have seen approximately 200 additional cases.

This experience with about 300 cases of ureteral stricture has been answering in a degree the question I have just mentioned. Their histories demonstrate what has been their treatment in an epoch in which we have failed to recognize the frequency and importance of ureteral stricture as a clinical entity. Many of them have been fortunate enough to escape operation, and because we could discover no lesion to account for their persistent symptoms, we have put many of them down as neurasthenics, and if they could afford it, they have had rest cures; or because of their gastro-intestinal symptoms, we have sent them to the gastro-enterologists to be drugged without relief, or we have sent them to the orthopedist to have braces for their hip, back, and sciatic symptoms.

Of those who have not been so fortunate and who have fallen into our surgical hands, the largest number have lost a normal appendix; many have had an ovary removed, some have had hysterectomies without relief. Some have had a useless gall-bladder operation. Many have had a fixation of the kidney without relief of symptoms because the symptoms, the slight hydronephrosis and the prolapse of the kidney all depended on a ureteral stricture. In some the stricture has been neglected so long that we have had to sacrifice the kidney.

This appeals to some of you as an imaginary list of ill-advised treatment, but I can

[1] Read before the Southern Surgical Association, St. Augustine, Florida, December 19, 1917.

assure you that all of these operations and many more have been recorded in these patients' histories, and some of the victims have not escaped with but one of these operations but have had two, three, or more of them, my most unfortunate patient having had 8 operations, 7 of them abdominal. These patients are consistent in still complaining of their original symptoms until the ureteral stricture is diagnosed and dilated.

Too many of these cases have been in my own list of useless operations, and I am now consulted frequently by some former patient who tells me of the operation I did one, two, or more years ago without giving relief and brings the typical history of ureteral stricture, which I find in her original records.

History of the theories concerning the etiology of urinary calculus. One of the interesting developments in this study of ureteral stricture and its influence on other important lesions of the urinary tract has been the demonstration that many stones in the urinary tract are probably first formed in the site of a stricture. A review of the literature shows that ureteral calculi have generally been ascribed a renal origin and that the development of ideas concerning the etiology of urinary stone may be classified roughly into three periods. The first period dates from early medical history to the latter part of the nineteenth century and may be called the "chemical" epoch, in which writers sought to explain the origin of stone in some obscure change in the composition of the urine. The second period includes the last two decades of the last century and the first few years of the present, and may be called the "bacteriological" epoch, in which writers emphasized the influence of micro-organisms on stone formation. The third period overlapping on the second is synchronous with the recently developing accurate methods of study and treatment of ureteral diseases, and may be called the "mechanical" epoch in which injuries and inflammatory diseases within and outside of the ureter have been invoked as frequent causative agents in ureteral stone formation.

The chemical theories include those dealing with heredity, race, climate, diet, drinking water, ingestion of alcohol, incidence of gout and rheumatism, faulty metabolism, etc., and date back at least to Galen (see Neuburger and Pagel, *Handbuch der Geschichte der Medicin*, ii, 711, and iii, 280), who claimed a relationship between stone formation and gout. Paracelsus spoke of an animal cementing substance from the food, a tartar filled mucus, as essential in the formation of the "sperma calculi." Sydenham and Boerhaave considered a specific diathesis, a characteristic variation of the metabolic assimilation, to be fundamental and to result in a crystallization of the stone-forming substance held in excess in the urine.

Van Helmont attributed stone formation to the coagulation of uric acid which came from the existence of potential alcohol and the breaking up of urinary ferments.

Fourcroy and Vauquelin considered the organic cementing material to be albumin and gelatin, and they, and later Scheele (1776) investigated the solid elements concerned in stone formation. Scheele referred to the "Steinsaure," the stone acid, or uric acid, phosphorus, and saccharic (oxalic) acid, ammonia, and the alkali earths, and Fourcroy classified the stones as consisting of one, two, or more than two of the stone-forming materials.

At the end of the eighteenth century, many authors, notably Wilson, 1795, wrote of the influence on stone formation of the frequent use of acid foods and drinks, and of the drinking of water rich in lime, and of the influence of sedentary habits.

In 1852 von Walther defined the spontaneous formation of calculi (i.e. those formed without the aid of foreign bodies) as an organically vital process, pointing out that with the same materials outside the living body only a sediment forms.

Meckel von Hemsbach, 1856, advanced the theory that the organic cementing material was the product of an advancing inflammatory condition, a catarrhal affection of the urinary tract, "Meckel's stone-forming catarrh."

In 1884 Ebstein by careful dissection and analysis of stones concluded with Fourcroy and Vauquelin that stones formed in the

urinary tract contain a framework of albuminous substance. He thought this organic material resulted from a catarrh of the urinary tract and a sloughing of the epithelium, thus forming a groundwork for the impregnation of the inorganic particles of the urine.

Posner accepted these two factors as important, but thought that, in addition to the sloughing of the albumin framework and its impregnation by crystalline bodies, we must have a third factor in stone formation, viz., a slowing of the urinary stream.

Kuester[1] reviews the history of the etiology of urinary calculi. He dismisses the views formerly held as to the rôles played by climate, drinking water, and racial tendency. Many cases even in the third and fourth decades of life may be traced to the uric acid infarct in the young. Gout as a cause cannot be proved although the two conditions are often present in the same individual. He quotes Ackerman as viewing stone formation as due to a retained hyaline cylinder in the kidney pelvis, and von Recklinghausen as considering a blood-clot the foundation for stone. Kuester says that if it be true as stated by Moritz and Mendelsohn that each stone particle has an albuminous center, then stone formation loses its specific character and belongs on the borderline between a physiological and pathological occurrence.

A. E. Roberts[2] of the English Army attempts to explain on dietetic grounds the unusual prevalence of bladder stone in certain parts of India where the inhabitants are vegetarians and where gout is almost unknown. Of 3,041 cases of stone in the bladder operated upon in one year in India, 1482 or nearly one-half were in the Punjab, where the inhabitants eat cereals and leguminosæ as opposed to the rice diet of other portions of India. These diet stuffs "yield urine which is as acid as that due to a meat diet, under normal conditions of digestion, because they are rich in albumin and phosphates and in calculus." The inhabitants of the Punjab have a deficiency of salt, which is so necessary with a vegetable diet, and Roberts considers this the cause of their prolific calculus formation. He then takes up what Hirsch in his great work on *Geographical and Historical Pathology* calls "the mystery of the excessive prevalence of stone in the tropics," while "gout is practically unknown," and attempts to show that absence of sufficient NaCl and excess of K in the diet renders the blood relatively alkaline, resulting in the dissolving and excretion of the uric acid as far as the bladder. On the other hand, a free ingestion of NaCl results in relatively acid blood with a storage of the uric acid in the spleen and joints (gout).

The bacteriological theories concerning stone formation are a natural outcome of the development of bacteriology and a clearer knowledge of the rôle of microorganisms in pathological processes.

Naunyn's work in showing the relationship between gall-stone formation and infections undoubtedly stimulated similar investigations on the etiology of urinary calculi.

M. L. Harris[3] advanced the thesis that all renal calculi are of bacterial origin and supported this by evidence collected from the literature, and by experimental and clinical data.

"The subdivision of kidney stones by Albarran, into primary and secondary stones, the former being considered of non-bacterial origin, and the latter of bacterial origin, however, is of great value, as will be seen later, if we base the classification not on the character of the stone, but on the state of the kidney. In primary stones the bacteria are eliminated by the healthy kidney. They develop in the urine in the tubules, calyces or pelvis, where they lead to the stone formation, as above described, without invading or setting up pathologic changes in the kidney proper.

"In secondary stones the kidney is already the seat of active bacterial invasion, and the stone formation is subsequent thereto. The great danger of primary stones is that they may determine bacterial invasion of the kidney, in which case they thereafter partake of the nature of secondary stones."

[1] Chirurgie der Nieren, der Harnleiter, 1902, p. 399.

[2] Vesical calculus in India, its distribution and a theory of its cause. Lancet, Lond., 1895, 1, 381.

[3] Renal calculi. J. Am. M. Ass., 1900, xxxiv, 643.

T. R. Brown[1] made accurate bacteriological studies of seven cases in which infection of the renal pelvis or the substance of the kidney was associated with the presence of stone. Careful qualitative chemical analyses of the calculi were also made and his conclusions were that with the proteus vulgaris and other alkaline producing infections, we may expect to find stones made up of the alkaline earths, while with the colon and other infections associated with acid urine, we may expect to find stones made up of the organic materials such as urates and oxalates.

We have seen that the formation of stone in the urinary tract has been a subject of intense interest and speculation since early medical history, and that we still have problems to solve concerning its etiology. Scientific knowledge of the diagnosis and treatment of urinary calculus has awaited the development of abdominal and pelvic surgery during the last quarter of the nineteenth century and the early years of this century. This knowledge and accuracy of treatment has been tremendously accelerated by the development of the specialty of urology with its use of the cystoscope, the renal catheter, and roentgenoyraphy.

We cannot emphasize the rapidity of this evolution more forcibly than by quoting from a paper by Henry Morris[2] of London, published in 1884 enunciating the principles concerned in the treatment of calculus impacted in the ureter: "As regards the question of surgical operation in which there is impaction in the ureter, there is no doubt but that in some of them the calculus could be removed by nephrolithotomy or pyelonephrotomy . . . . and there is good reason to believe that with the more frequent resort to digital exploration of the kidney, through a lumbar incision, a calculus impacted in the upper end of the ureter will not infrequently be detected, and extracted through the loin . . . . Calculi impacted in the intermediate parts of the ureter are practically beyond the reach of the surgeon."

It has been the development of abdominal and pelvic surgery and especially of urology that has led to ureteral surgery and to a gradual appreciation of the importance of mechanical factors in the etiology of ureteral stone formation. A few quotations from recent literature will show that the ideas held by the author are at variance with many of our past ideas, but that they are confirmatory and elaborative of some of the recent theories, rather than original.

Israel[3] says, "the cause of stone formation is still in the dark. One theory is that uric and oxalic stones are due to a poor oxidation of the proteids. It seems certain that heredity plays a part in the predisposition to stone formation. The uric acid and cystin stones run in families. It is also certain that in some families gout, rheumatism, diabetes mellitus, nephrolithiasis, and bladder-stones alternate. Subcutaneous trauma may play a rôle. Injury to the kidney causes bleeding. It is more probable that latent stones begin to give trouble after trauma. It is only hypothetical whether there is such a thing as Meckel's stone-forming catarrh." Israel cites "a case due to stenosis following lateral fistula due to injury to the ureter by a clamp during vaginal hysterectomy. Another case had colic following misplacement of the ureter by a vaginal fixation. Therefore, one should always remember that a former gynecological operation may be the cause of kidney colic. The cramp-like pains due to the rare condition of primary ureteritis cannot be diagnosed from kidney-stone colic. A diagnosis is practically impossible when the colic is due to the form of ureteritis in which small concretions are passed, these having been formed in the ureter, their nucleus being a small organic mass. Colic due to primary stricture of the ureter is very rare."

Benjamin R. Schenck,[4] speaking on the etiology of ureteral calculus, states: "Calculi formed primarily in the ureter are very rare. While they may result from urinary deposits about the site of an old infection or ulceration, they more frequently occur after operations on the ureteral walls, as when a non-absorbable suture becomes the nucleus of an irregular deposit of phosphates or urates.

[1] On the relation between the variety of micro-organisms and the composition of stone in calculous pyelonephritis. J. Am. M. Ass., 1901.

[2] Am. J. M. Sc., 1884, lxxxviii, 458.

[3] Nierenkrankheiten, 1902.

[4] The symptoms, diagnosis, and surgical treatment of ureteral calculus. Johns Hopkins Hosp. Rep., 1902, x, 477.

"The presence of a foreign body, such as a calculus, beginning its descent, must cause a spasm of the muscular coats, and this we consider an important factor in causing the arrest of the stone. Added to this we have, in cases where infection is present, inflammatory reaction and swelling of the mucosa, which later cause thickening and rigidity of the ureteral walls and finally stenosis at point of arrest. Such, as far as is known, are the general etiological factors."

R. C. Bryan[1] speaking of the etiology of ureteral stone, states: "The possibilities of transmural bacillary infection must be considered as a constant menace to the ureter integrity, particularly if its mucosa has been insulted by the frequent passage of a concentrated urine loaded with irritating crystals such as oxalate of lime, or if, indeed, its wall has either mechanically or by processes of inflammation been restricted or damaged, as may be instanced in childbirth, appendiceal, ovarian, tubal, and peritoneal exudates, and consequent fibrotic replacements."

He also says: "As another and more recently developed causation of primary ureteral stone, must be mentioned *stricture*. The acquired variety has been briefly mentioned above. In regard to the *congenital*, Bottomley[2] records 56 cases of congenital stricture of the ureter. Such a stenosis, if complete, would result in atrophy of the kidney, or hydronephrosis. If of small caliber, there would be proximally a d latation and thickening of the ureteral wall. The opportunity here, through stagnation for stone building, would seem evident and is directly comparable to stone formation in a bladder behind an obstructing prostate."

Guiteras[3] considers most ureteral stones as secondary; the rare primary stones are of a phosphatic origin and small.

J. M. Thompson Walker[4] says: "Very rarely a calculus is formed in the ureter itself." He gives examples of calculi formed around sutures and other foreign bodies.

John H. Watson,[5] surgeon to the Victoria Hospital, Burnley, in his paper on Ureteral Stone states: "There are, however, certain general facts which may be well worth recalling in these cases. In the first place, stone in the ureter is certainly more prevalent than is supposed; according to some writers it is of greater frequency than renal calculus. They may arise in the ureter, but as a general rule they form in the renal pelvis and then pass into the ureter; the etiology is therefore practically that of renal calculi, which is still a vexed problem."

Braasch and Moore,[6] under the section on treatment, state: "In the consideration of ureteral stone its renal origin should be borne in mind." Further data from this valuable contribution will be referred to later.

O. S. Fowler,[7] of Denver, has called attention to the possible importance of stasis in the etiology of stone formation. He attributes the stasis to a kink in the ureter due to prolapse of the kidney as demonstrated by the method he has done so much to develop of taking pyelo-ureterograms in the erect posture. Almost all of his roentgenograms, however, reveal ureters which are dilated below the point of kinking as well as above, and I would interpret them as being cases of unrecognized ureteral stricture low in the channel, causing a dilatation of the ureter and kidney pelvis, and a prolapse of the heavy hydronephrotic kidney, resulting in apparent kinks in the upper ureter. I have several ureteral stricture cases showing this kidney prolapse and apparent ureteral kinking, but they all show the ureteral dilatation down to the stricture area, as illustrated strikingly in Figures 1 and 2. Reference to Figure 3 shows a remarkable circular twist of the upper ureter at the ureteropelvic juncture. This patient had a kidney fixation six months before this pyelo-ureterogram but continued to suffer with renal colic. Viewing this picture one might say that the renal attacks continued because of faulty fixation of the kidney, resulting in this pelveo-ureteral twist, but

[1] Stone in the ureter. Surg., Gynec. & Obst., 1911, xii, 134.
[2] Ann. Surg., Phila., lii.
[3] Urology, 1912, i, 633.
[4] Surgical Diseases and Injuries of the Genito-Urinary Organs, 1914, p. 319.
[5] Brit. M. J., 1915, i, 993.
[6] Stones in the ureter. J. Am. M. Ass., 1915, lxv, 1234.
[7] Ureteral obstruction causing urinary stasis; a new etiology in kidney stones, etc. J. Am. M. Ass., 1914, lxii, 367.

Fig. 1. To illustrate picture often seen in roentgenography and heretofore interpreted as hydronephrosis due to ureteral "kinks." X-ray catheter obstructed in a kink. Note the dilatation below the kinks, showing that the real cause of obstruction is lower. The symptoms in these cases clear up without fixation of the kidney after thorough dilatation of the strictures and establishment of free urinary drainage. Fixation of the kidney without dilating the stricture is followed by further symptoms.

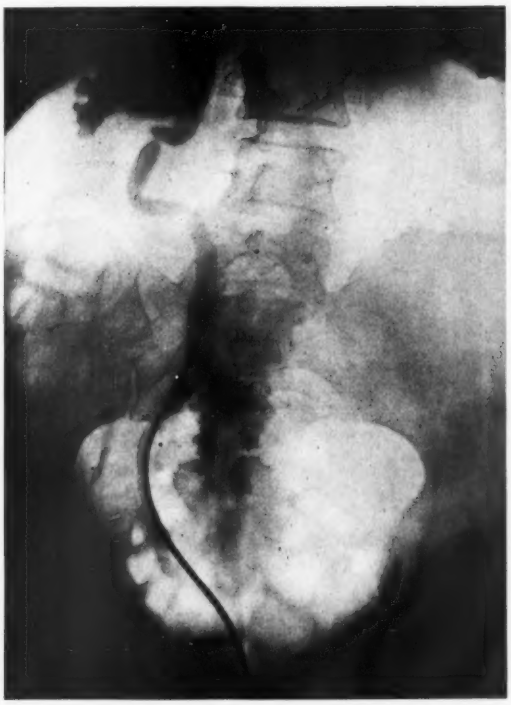

Fig. 2. Same patient as illustrated in Fig. 1, the catheter being withdrawn until the wax bulb, located 10 centimeters from the tip of the catheter, has obstructed in the upper stricture at the iliac gland region. Note slight dilatation of the ureter between this stricture and the lower stricture in the broad ligament region.

the patient's symptoms were entirely relieved after dilatation of the two strictures in the lower ureter.

Reference to Figure 4 shows a decided displacement and kinking of the right ureter in the appendix region and stasis above, which might be interpreted as ureteral obstruction due to an old appendicitis, but reference to the legend and report of Case 2 will show that this illustrates the condition found in a patient who was probably suffering with what I have described as simple stricture of the ureter.[1]

[1] Hunner. Chronic urethritis and chronic ureteritis caused by tonsillitis. J. Am. M. Ass., 1911, lvi, 937; Ureteral stricture, report of 100 cases. Johns Hopkins Hosp. Bull., 1918, xxix, 1.

While Rovsing,[2] was one of the early modern writers on ureteral stone, I have reserved quotations from him until the last because of his clear manner of stating that ureteral stone may form in a stricture.

He affirms that a stone may arise in the kidney and become obstructed in a narrow portion of the ureter, or it may arise primarily in the ureter "due to a stasis of the urine by a stricture, be it a congenital stricture or valve formation, be it the result of tuberculosis, or other suppuration and ulceration processes."

He takes the position that an infection is present at the same time, which results in the deposit of hard urinary particles about the inflammatory organic elements.

[2] Erfahrungen ueber Uretersteine. Monatshr. f. Urol., 1901, vi, 385.

Fig. 3. Apparent twist in ureter at kidney pelvis.[1]

Fig. 5. Illustrating case with periodic hæmorrhage probably from a stricture area.

Fig. 4. Ureteral stricture case with displacement of ureter in appendix region.

Of the 16 cases of ureteral stone which he had observed he was ready to assert that but one had certainly had its origin in the ureter itself. This was in the case of a woman who had worn an insanitary pessary which Rovsing considers to have caused pressure on the ureter, resulting in a narrowing and inflammation, above which the stagnated infected urine could deposit its phosphates around the pus cells and fibrin shreds.

Rovsing takes up the consideration of the factors which may hinder a concrement which forms in the kidney and descends into the ureter from passing entirely through the ureter. He mentions as a physiological factor the three normally narrow areas in the ureter, and the pathological factors he divided into two groups, the intra-ureteral and the extra-ureteral.

In the first pathological group belong congenital valve formations or narrowings of the ureter, and inflammatory stricture, be it of simple or of tuberculous origin. Rovsing finds the suggestion in the literature

[1] For full description of this and the following plates, see case reports at end of article.

that the passage through the ureter of sharp edged concrements may wound the ureter and thus set up stricture formation and constriction for the stoppage of later concrements. He doubted whether any of his cases belonged to this class.

The extra-ureteral pathological processes which may cause the arrest of a stone may be tumor formations which compress the ureter, or disease of the surrounding tissues. The ureter may be situated in the contracted connective tissues and be compressed by them or it may be retracted laterally to form a kink and consequent blockage of a stone. He considered two of his cases as belonging to this category. One, a woman 40 years of age had a severe illness 18 months before her first ureter colic. This he interpreted as being due to a right-sided tubal pregnancy, resulting in an exudate behind and to the right of the uterus, displacing the uterus toward the right and leading to a sharp kinking of the left ureter in which he demonstrated a stone. In a second case he found

Fig. 6. Ureteral stricture with hæmaturia.

Fig. 7. Ureteral stricture with hæmaturia.

Fig. 8. Bilateral stricture and stone in one stricture.

Fig. 9. Bilateral stricture with stone in one stricture.

Fig. 10. Multiple strictures and stone in upper stricture.

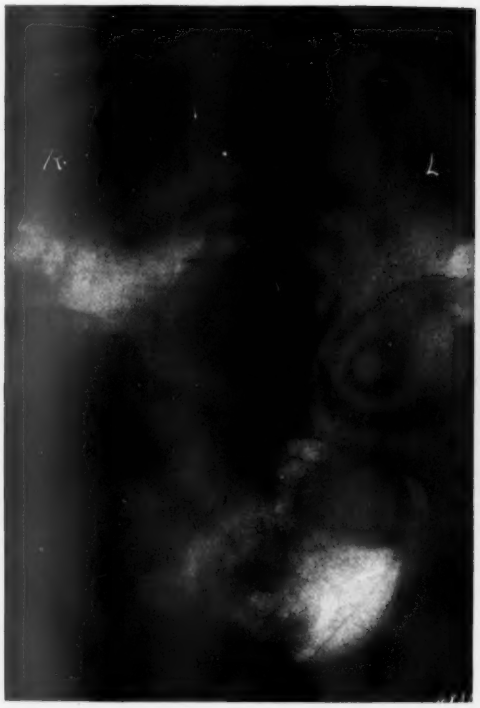

Fig. 11. Same patient as Figure 10.

pyuria and a finger-sized calculus above the cervical portion of the uterus in a woman, who had had puerperal fever with peritonitis attacks and had been confined in bed for six months.

Statement of the author's views. Except for the one factor of the intermittent gush of urine which tends to sweep any foreign material from the ureteral lumen, a ureteral stricture presents the ideal conditions for the formation of calculus. The strength of the normal gush must be increased in the narrowed stricture area, and yet there must be some interruption and eddying of the stream in some cases, thus making a degree of stasis favorable to stone formation. Our histologic studies of the stricture area have shown a change in the type of epithelium from the stratified transitional to the squamous, and that in some strictures there is actual ulceration. The urinary analysis

Fig. 12. Same patient as Figs. 10 and 11.

Fig. 13. Illustrating a case with two strictures in the pelvic portion of the left ureter; a stone in the lower stricture obstructing the catheter; and shadow of thorium dilating the ureter between the two strictures. Recently developing symptoms from right ureteral stricture.

shows blood in a fairly large percentage of stricture cases. This blood in some cases is probably due to overdistention and trauma to the kidney pelvis when the stricture swells shut, and in other cases it is undoubtedly due to bleeding from the ulcer at the stricture area (see Figures 5, 6 and 7). A slight oozing and coagulation to form a small blood-clot at the stricture site would form an ideal nidus for the deposit of urinary salts, particularly with the added factor of stasis of the urine.

Without actual ulceration of the stricture mucosa, we probably have other factors favoring stone formation, such as an excess of a serous or mucoid secretion as found elsewhere in catarrhal conditions of the mucosa, an increase in the desquamation of epithelium and irregularities of the surface to favor the retention of these organic exudates, and the deposit of inorganic precipitates.

It is probable that these mechanical theories do not fully account for the formation of stone in the ureter.

If they were all sufficient, we would find ureteral stone in a much higher proportion of stricture cases than we do, and furthermore, we would expect to find stone in the bladder much more frequently. In many cases of bladder inflammation, which come under observation, we have the ideal mechanical conditions for stone formation, such as ulceration, bleeding, increased exudation of serum and of epithelial cells, and a comparative stasis of the urine.

In a very small percentage of bladder ulcers do we find stone formation. It is apparently favored when the urine carries a proteus or some other alkaline-producing organism, but the bladder ulcer may be covered with urinary salts in the presence of an acid urine and colon bacillus infection. Whenever we find a bladder ulcer covered with fibrinous and mucoid material, impregnated with urinary salts, we have potential stone formation, and it is probably the constant activity of the bladder walls plus the free drainage

Fig. 14. Recent X-ray of a ureteral stricture case.

Fig. 15. Removed kidney and upper ureter from patient illustrated by Fig. 14.

Fig. 16. Fig. 17.

Fig. 18.

Fig. 16. Stone from Case 9, illustrated in Fig. 13. Note depth of lateral channel for free passage of urine. It is probable that the patient's symptoms came from the obstruction by the upper stricture rather than from this stone situated in the lower stricture.

Fig. 17. Stones passed spontaneously 10 days after dilating the ureter with a No. 16 (5⅓ mm.) gum elastic bougie. Increasing sizes of bougies had been used in 7 treatments at intervals of two weeks. These stones were passed by a stout patient who had been operated upon one year previously for the removal of abdominal fat, and it was particularly gratifying to avoid a second operation in her case.

Fig. 18. *a*, Gall-stone; *b*, appendix stone from one of the author's ureteral stricture cases, whose symptoms were due to ureteral stricture; *c* ureteral stone from another stricture case, showing deep channel for free passage of urine, the patient's hydronephrosis symptoms probably due to a dense ureteral stricture located 3 centimeters below the stone and about 3 centimeters above the bladder; *d*, ureteral stone removed from stricture area 5 years after treatment of ureteral stricture (see Figs. 14 and 15).

through the relatively large urethral canal that determines the breaking off and extrusion of these potential calculi.

Similar factors of peristalsis and force of the urinary stream tend to clear out incipient ureteral calculi, but the narrowed channel at the site of the ureteral stricture tends to hold these calculi and determines a much larger number of stones in the ureter as compared with the bladder.

While the presence of an infection probably favors stone formation by intensifying inflammation, causing more serous and epithelial exudate, and by decomposing the urine and setting free its solid constituents, and at times, by furnishing clumps of organisms as a nucleus for stone, we must admit that we find many stones in the urinary tract unassociated with infection. It might be argued, as held by Harris, that infection was present and was a factor in the laying down of the stone nucleus, and that the infection cleared up later. We believe the presence of a stone in the tract would tend to perpetuate an infection, and in many of our stone cases there has been no past history suggesting a pyelitis or a cystitis. It is true that a patient with stone may have had an unrecognized pyelitis or cystitis attack, the symptoms of which were not marked and have been forgotten by the patient when she presents herself with evidences of aseptic stone in the tract.

Our conclusions are, therefore, that ureteral stricture plays a rôle in stone formation of far greater importance than has been realized heretofore. The majority of ureteral stones probably form within a stricture area. Some of these escape and give rise to bladder stones or are passed. Some stones formed in a stricture area probably escape and float upward and become kidney stones.

While we have in ureteral stricture the ideal conditions for stone formation considered from the "mechanical" viewpoint, we must credit the presence of "bacterial infection" with a share in the formation of some calculi, and it is probable that the "chemical" or "specific diathesis" theory cannot be eliminated if we are to account fully for this pathologic phenomenon. We

Fig. 19. Utereral stricture, case.

see an occasional patient who repeatedly passes uric acid calculi from the kidney, in whose urine we are not able to detect unusual changes and in whose urinary tract we are unable to demonstrate any abnormality during life. Such cases might be credited to a low grade nephritis but we usually think of this type of stone formation as due to "faulty metabolism," obscure biochemical changes, or some such poorly understood diathesis.

The formation of the rare fibrinous calculi, according to Gage and Beal[1] is probably preceded by a hæmaturia.

Clinical observations supporting the view that ureteral stones often arise primarily in a stricture. The extremely small size of many ureteral stones found encased in dense ureteritis tissue is an argument against the old view that the ureteritis is due to the

[1]Ann. Surg., Phila., 1903, xxxvii, 387; 1910, li, 111.

Fig. 20. Ureteral stricture, suffering with left kidney colic several years. The X-ray revealed a stone in the pelvis of the kidney. Investigation with the wax-tipped catheter accidentally led to the discovery of ureteral stricture 7 centimeters from the bladder, the kidney pelvis holding 8 cubic centimeters. Complete relief of symptoms after dilatation of the stricture, and the patient refused operation in spite of being shown the X-ray of her kidney stone. This case probably explains the occasional case seen by the surgeon in which pyelotomy for stone is followed by urine drainage for a disappointing length of time, and after healing the patient continues to have symptoms similar to those before complained of.

Fig. 21. Showing obstructed X-ray catheter in right ureter and stone in right kidney pelvis. Ureteral stricture case 50. Age 32 years, the only case in about 300 with stricture near the kidney. Catheter diverted laterally just above the pelvic brim and stopped at this same point in roentgenograms taken on 3 different days. Could not inject sufficient thorium into the kidney to get a definite shadow of pelvis. Nephrectomy; stricture immediately below enlarged pelvis would not take the fine silver probe. The patient had suffered attacks since early childhood, the pain beginning in the appendix region; and as it grew more severe it traveled diagonally across the abdomen and settled in the left kidney region. Operation three years previously, removing a diseased appendix and chronic pelvic inflammatory trouble, but without influencing her chief symptoms.

Fig. 22 (below). Renal catheter with "cork-screw" or spiral wax-tip, and spindle shaped wax-bulb. The pure beeswax is used. For the first investigation the bulb should be small, 3 to 4 millimeters in diameter, and may be increased gradually in size to 6 millimeters.

Fig. 23. Graduate gum elastic dilating bougie, 38 centimeters long, the pointed tip gradually increasing in size until full diameter is reached about 15 centimeters back of the end. Sizes 18, 20, and 22, 7⅓ millimeters diameter, are most useful. This dilator is useful for the final dilatations of ureteral stricture and for dilating to bring down stones in the pelvic ureter. The early investigations for stricture and stone are made with the spiral tip, wax bulb renal catheter, Figure 22.

irritation of the stone. Such small stones, if formed in the kidney, would pass entirely through a normal ureter.

The occurrence of bilateral stricture with the presence of a stone only on one side argues for the secondary character of the stone. If the stricture formation were dependent on the irritation of the stone, we would expect to find bilateral stone. Five of my cases have shown this condition and three of them are illustrated by Figures 8, 9, 13, and 16.

Multiple stricture in one ureter with a stone in but one stricture area is suggestive of the strictures being primary, although one might argue that the stone caused one of these strictures and then passed up or down and set up a second point of irritation and ureteritis. Figures 10, 11, 12, 13, 16 and 18-*c* illustrate three out of several cases of this kind which have come under my observation.

Case 71 of my ureteral stricture cases was a patient aged 37 years, who had suffered for eight years with left renal colic, the attacks becoming so severe recently that they required several hypodermics of morphine for their control. The urine was smoky with blood and contained pus and a colon bacillus infection. On passing a catheter prepared with small wax rings at intervals of 5 centimeters for locating the possible ureter stone, and with one large wax bulb to dilate the ureter, the catheter returned with scratch marks on all the rings within 20 centimeters of the tip. The eye of the catheter contained a particle of stone and the large wax bulb had embedded in its surface about a dozen particles of stone. The patient was completely relieved of her severe colic attacks and subsequently had several dilatations of the stricture area until her symptoms were relieved. She had the contracted type of pelvis holding but 4 cubic centimeters. Scratch marks were never obtained after the first treatment which seemed to have entirely cleared out the incipient stone formation.

In ureteral stricture Case 13, seen with Dr. Pancoast, there was an obstruction in the ureter 6 to 7 centimeters above the bladder, and on two occasions definite scratch marks were obtained on the wax tip and bulb. A tender nodule could be palpated in line with the ureter and on vaginal ureterotomy, 7 days after the second ureteral dilatation, a dense scar tissue area was opened but no stone was found. Dr. Pancoast then explored and drained the large hydronephrotic kidney and at subsequent dilatations of the patient's stricture area, scratch marks were not obtained. It is probable that the patient had either passed her calculus before our operation, or the stone was so small that it escaped our notice while we were doing the vaginal ureterotomy, or the stone had floated up and after operation, escaped through the nephrotomy wound.

The large ureteral stone, Figure 18, *d*, was removed from the right broad ligament region in my ureteral stricture Case 9 five years after I had repeatedly dilated strictures in the right broad ligament and iliac gland regions, and in the left broad ligament region. Figures 14 and 15 show the condition found in the kidney three years after removing this broad ligament stone and it might be argued that this stone originally formed in the kidney and became lodged in the lower ureter where it took on the ureteral stone form.

A stone having formed in a stricture area may persist for years with comparatively few symptoms due to the fact that the urine tends to channel one side of the stone and keep a free passage (see Figs. 16 and 18, *c*). Such a channeled stone may shift its position, due to a fall or some form of sudden exertion by the patient, when the lumen may be blocked and a typical sudden colic supervene. Such a sudden obstruction, if unrelieved, leads to serious consequences to the already partially damaged kidney, and it may lead to reflex anuria and death of the patient, particularly if the opposite kidney be below par from the effects of stricture or stone in its ureter or from any other cause.

The sudden shifting of position and consequent blockage may result in such a head of pressure that the stone is swept out of the ureter and becomes a bladder stone or is passed to the outside. Figures 19 and 5

illustrate cases in which the patients had passed ureteral stones but continued to have symptoms until dilatation of their ureteral strictures. In one of my ureteral stricture cases the patient had suffered with bladder discomfort and incontinence for nine months and I removed a stone 15 millimeters in diameter from the bladder. Six or eight years previously the patient had suffered a severe colic attack on the left side requiring morphine. The X-ray showed in addition to the bladder stone a small shadow in the left broad ligament region, and investigation with the wax-tip and wax-bulb catheter demonstrated this to be a phlebolith but the patient had two strictures in the broad ligament region and a left colon bacillus pyelitis, with kidney content of 21 cubic centimeters.

It is likely that the records of a stone taking many years to pass or to reach a certain point in the ureter before its removal by operation are often records of patients who have suffered for years with ureteral stricture and have more recently developed a stone in the stricture area.

The comparatively frequent association of kidney stone with ureteral stricture (five cases in my first 50 ureteral stricture cases, see Figures 20 and 21) convinces me that some stones forming in a stricture may eventually become released, float upward and become kidney stones. Such stones may remain in the kidney permanently or they may be migratory, being found either in the kidney or ureter; or they may increase in size while in the kidney pelvis and eventually begin a descent and become blocked in some portion of the ureter above the stricture site, or make their way back to the stricture site, where they completely block the ureter because of their increased size and lack of lateral urinary channel, such as we usually find in those stones which have always remained in the stricture area.

I believe that this peripatetic character of some stones explains some of the problems suggested by Braasch and Moore, whose report on the vast experience and accurate observations of the Mayo Clinic furnish us with one of the most valuable chapters on ureteral stone. In their paper above referred to they state: "The majority of the stones in the pelvic portion were not lodged exactly at the point of narrowing at the ureterovesical juncture but a short distance above it." My work on ureteral stricture has shown that the stricture occurs in the broad ligament region, or within 6 centimeters of the bladder, in 82 per cent of the cases. By far the greatest proportion of these strictures were at a point 3 to 4 centimeters above the bladder rather than in the ureterovesical juncture.

Braasch and Moore state that of those stones described at the ureteropelvic juncture, the majority "were found a short distance above the point of narrowing." Contrary to the past literature on ureteral stricture, which has considered this lesion of congenital origin and located it at the points of congenital narrowing in the ureter, I have shown that stricture in the pelvic brim region does not occur at the ureteropelvic juncture but at the iliac gland region 3 or 4 centimeters below the pelvic brim (17 per cent). Some of these stones, which Braasch finds a short distance above the pelvic brim, were probably formed in the kidney, and some were probably formed in a ureteral stricture and had traveled back to the kidney, where they increased in size and on returning to the ureter, they were too large to reach the pelvic brim. The same is probably true of the group of which he states: "It is difficult to explain the large number of stones found in the upper third of the ureter." He states: "The majority of such stones, however, were of considerable size." He also states: "The average size found in the lower third of the ureter was much smaller than those found in the upper ureter" (these lower stones have always remained in the stricture areas). Braasch states: "As a general rule, stones situated in the ureter at points other than those of natural narrowing were larger and caused more renal destruction than the others" (stones which lack the lateral urinary channel so often found in those stones permanently fixed in a stricture area).

Practical clinical deductions. This study was undertaken to emphasize the importance

of ureteral stricture as an etiological factor in the formation of urinary calculus.

A few clinical deductions following from this thesis are of such practical importance that it seems appropriate to give them space in this paper devoted to etiology. Ureteral stricture is of such frequent occurrence that every case demonstrated by X-ray to have a small stone in the kidney pelvis, should have investigation for the presence of ureteral stricture before operation (see Figure 20). In lieu of such pre-operative investigation, such cases at operation should have a renal catheter, carrying a 4 millimeter wax bulb within 3 centimeters of its tip, passed through the pyelotomy opening downward into the bladder. Such a wax bulb will serve to detect and dilate an occasional stricture low in the ureter. If a stricture is discovered in this manner, drainage should certainly be left down to the pyelotomy wound to take care of possible leakage due to the swelling shut of the stricture area incident to the trauma of its first dilatation.

The returning wax bulb should be investigated for scratch marks, for in rare instances an unsuspected ureteral stone will be indicated by this test.

The above instructions apply with equal logic to operations for ureteral stone located above the pelvic brim, particularly if the stone is found in a dilated ureter and is not encased in an area of dense infiltration (probably a migrating stone). In operating for a stone in the lower half or pelvic portion of the ureter, one will usually find such stone in a stricture area located either a few centimeters below the pelvic brim (iliac gland region) or a few centimeters above the bladder (broad ligament gland region). In view of the comparative frequency of multiple strictures in the pelvic ureter, careful investigation should be made for other strictures than the one encasing the stone (Figures 10, 11, 12 and 13). With a well channeled stone, it is more than probable that the symptoms are due to the second stricture, although one occasionally sees a case with marked symptoms due to a single stricture with a well channeled stone, the symptoms probably being due to the stone shifting position.

On finding a stricture area about a stone, this should always be thoroughly dilated as a part of the operation. It is preferable, when possible, to make the ureterotomy opening in the dilated portion of the ureter above the stone, and then to grasp the stone with delicate forceps and drag it up through this opening, or to "milk" the stone out of its stricture bed and up to the ureter incision. Unless the stone is large enough to be well outlined in its stricture bed, one is likely to have trouble in dislodging it, and in such cases, it is better to cut directly into the stricture area and on the stone. The dilatation of the stricture must then be carried out in both directions from the ureterotomy opening.

In operating for a fairly large stone in a stricture area, one occasionally finds a second smaller stone or a nest of small stones just above or below the large stone. Great care should be taken to prevent these smaller stones from escaping up or down in the ureter to cause future trouble.

With added experience we should get most small stones in the pelvic ureter to pass spontaneously. Figure 17 shows the largest stone I have dislodged by this method. Figure 23 shows the type of gum elastic graduate dilating bougie I am now using with much satisfaction in the later treatments for ureteral stricture and for dilating in the stone cases after using my spiral tip wax-bulb catheter (Figure 22), for the early work in testing for scratch marks, dilating the stricture, getting its location, the size of the kidney pelvis, lavage, culture taking, and estimating the renal function. In dilating for stone, one should avoid treating too frequently. My experience with ureteral stricture dilatation has shown that it takes from a week to ten days for the œdema, incident to the trauma of treatment, to subside fully. This corresponds with my experience in getting ureteral stones to pass. They usually escape in 8 to 10 days after the last dilatation. Occasionally, after the ureter has been previously stretched by repeated and increased caliber dilatations, a stone will come down within the first few days of the last treatment.

CASES SHOWN IN PLATES

CASE 1. Mrs. B., age 28, referred by Dr. Bay May 15, 1917. Attacks of pain in the right side for 4 or 5 years. First attack came suddenly and lasted 2 or 3 hours. Two or three attacks within a month, then none for about a year, then awakened one morning at one o'clock with such a severe attack she could hardly get out of bed. For the past 3 years she has had 2 or 3 attacks a week but has gone for 2 or 3 months without an attack. There has been some pain in the side almost every day since the first attack. In November, 1916, Dr. Bay did an appendicectomy and fixation of right kidney. Four days after leaving hospital the patient had one of her typical attacks and continued to have them for 6 months until the strictures were dilated. The kidney holds 15 cubic centimeters. Two strictures, one at about the bifurcation of the internal iliac vessels, and one within 2.5 centimeters of the bladder. Symptoms relieved after two dilatations. This patient's family physician, Henderson Irwin, of Eureka, North Carolina, after the experience with this one stricture patient, diagnosed a second case in November, 1917, and brought her to me for confirmation of his diagnosis and for treatment. He then reported this first patient as enjoying good health and having gained 16 pounds in weight in the seven months. (Fig. 3.)

CASE 2. Mrs. W., age 30, referred by Carroll, Wallace, North Carolina, July, 1917. Pain in the right back for the past 15 months. Pain of a dull character most of the time with intermittent colics. For the past month almost daily severe colics, some of them requiring hypodermics of morphine. Pain in the lower right pelvis, reflected to the right hip and right buttock with frequency of voiding, the pain being worse rather than better after voiding. Never noticed blood in the urine. Note X-ray catheter obstructed a few centimeters above the bladder. Thorium picture shows some dilatation of the ureter from this point to the pelvic brim region, where the ureter is drawn laterally into rather sharp angles and shows rather greater dilatation above this point. The kidney pelvis holds 15-cubic centimeters. One would be tempted to interpret this as a case of ureteral kinks due probably to an old appendix inflammation but on later investigations, we found four definite stricture areas, the highest one being 10 centimeters above the bladder or slightly below the pelvic brim and the patient's symptoms were relieved by dilatation of these strictures. In November, 1917, the patient returned with increasing symptoms on the left side and we found two stricture areas at points 7 and 4 centimeters above the bladder in the left ureter. This we consider fairly good evidence that the patient's condition was one of so-called simple stricture of the ureter and the apparent kinks at the pelvic brim region were not concerned with the original symptoms. (Fig. 4.)

CASE 3. Mrs. L., age 29, referred by Jefferies Buck, in August, 1917. The patient had had pain in the left back for about one year. In April, 1917, about 2 days before her menstrual period, the patient had an extra amount of pain in the kidney region and then a terrible attack, lasting two hours, of pain throughout the left side and hæmorrhage in the urine. This two-hour attack ended by the passage of a calculus. The patient felt the cutting of the stone in the urethra and heard it strike the toilet basin but did not recover the stone. Since April she has felt much better except for the 48 hours preceding each menstrual period, when there has been an increase of pain in the back and low in the left pelvis and a passage of much blood in the urine. Since the passage of the stone, there has been a sensation of fullness in the bladder and diurnal frequency.

Examination revealed thickening of the broad ligament portion of the left ureter, tenderness, and a desire to void on palpating this induration. Urine from the bladder, macroscopically clear; microscopically, many erythrocytes, no leucocytes, no bacteria, no albumin. Wax bulb test demonstrated stricture 2 centimeters above the bladder. Injection test showed a kidney content of 6 cubic centimeters, a small pelvis. This thorium X-ray shows a small pelvis but a slightly dilated ureter. Three treatments with increasing sizes of wax bulb up to 5 millimeters followed by complete relief. (Fig. 5.)

CASE 4. Patient, age 69, referred by Hardee Johnston, Birmingham, Alabama, admitted to the Church Home and Infirmary May 18, 1917. Since April 5, 1917, she has had four attacks of hæmaturia, each attack lasting four days. There is no pain but a slight uneasy feeling in the right flank during the attacks. A renal catheter enters the right ureter only 3 to 4 centimeters. Thorium injection beyond catheter of 13 cubic centimeters. Later two successful dilatations of stricture 3 centimeters from the bladder. Report October 1, 1917, no further bleeding and no symptoms. (Fig. 6.)

CASE 5. Miss S., age 24, seen in consultation October, 1917, with Dr. Casler. Scarlet fever at 9, followed by "catarrh of intestines," constipation, and mucous stools. Gastric lavage weekly for three years by Dr. Friedenwald. At 16 years of age, onset of attacks of pain in the right side, exaggerated at the menstrual period and accompanied by fever. The attacks occurred about every two weeks for a period of 8 months when Dr. Finney removed the appendix. The attacks continued but apparently in milder form and she thought they were due to the menstrual periods. In January, 1915, adenoids were removed, the tonsils having been removed the winter before her "appendicitis" operation. January 1, 1917, an attack of grippe followed by an exaggeration of her pain in the right side and constipated bowels. Dr. Fisher operated for intestinal adhesions January 27, 1917. In May, 1917, Dr. Casler discovered ureteral stricture with infected hydronephrosis. The patient had been afflicted with repeated crops of boils ever since her "appendix trouble" began. This skin trouble improved after Dr. Casler got rid of the patient's staphylococcus aureus kidney infection by dilatation of the stricture and lavage. When I saw the patient with Dr. Casler she was still having pain in the right side at times and rather frequent hæmorrhages with the passage of clots in the urine. With more extensive dilatations of the stricture area, the bleeding ceased but the patient still has occasional attacks of pain. (Fig. 7.)

CASE 6. Miss G., age 26, referred by Fletcher Jordan, Greenville, South Carolina. Tonsillitis since childhood. Intermittent renal colics on left side for one year, on right side for 3 months. Stone 3 centimeters from bladder on left side in dense stricture area. Dense stricture 3 centimeters from bladder in right ureter. Bilateral hydronephrosis. Urine not infected. Left ureter exposed by extraperitoneal inguinal incision, stone removed and stricture dilated. During convalescence the right ureteral stricture dilated by the vesical route and diseased tonsils removed. (Fig. 8.)

CASE 7. Mrs. C., age 48. Severe renal attacks on right side for 18 months, requiring much morphine. No symptoms on left side. Urine catheterized from bladder shows leucocytes, erythrocytes, colon bacilli, and a trace of albumin. Stricture of right ureter 2 or 3 cm. from bladder. On catheterizing to obtain Figure 9, we found unsuspected obstruction and dilatation of left side. The right side held 38 cubic centimeters and the left 30 cubic centimeters. After withdrawing the catheter from the

left side and finding scratch marks on the wax bulb and tip, the small stone shadow was discovered in the lower end of the left ureter, at a point symmetrical with the stricture of the right side. Examination with wax tip bougie 24 days later showed that the stone had been passed.

CASE 8. Mrs. R., age 49, referred by Erasmus Kloman. For 6 years, she had had intermittent colic-like pains in the left side and back and radiating down course of ureter, accompanied by nausea and vomiting. After this plain X-ray demonstrating the shadow of a stone apparently located in the upper pelvic portion of the left ureter, Figure 11 was taken. A No. 7 whistle tip catheter was prepared with wax rings and a large wax bulb and it was successfully passed to the kidney. About 2 ounces of urine escaped rapidly and 75 cubic centimeters of thorium were introduced to the kidney for this X-ray photograph. On withdrawal of the catheter, the wax bulb hung definitely in two areas, and the wax bulb and the small wax rings within 15 centimeters of the end of the catheter were deeply scratched on one side. The patient continued in her uræmic and weakened condition with much nausea and vomiting, but had less pain after the passage of the wax bulb until the eighth and ninth days, when there was a great increase in pain. We hoped the stone was passing but the patient's condition was so threatening, that we decided to operate (see Fig. 12). On the way to the operating-room Figure 12 was taken, showing that the stone had left its original site and had caught in the broad ligament region, probably in a stricture area, as indicated by the second "hang" of the wax bulb. McBurney muscle-splitting extraperitoneal incision low over the left pelvis, the dilated ureter easily identified at the pelvic brim region and a tape passed under it. At the region of the internal iliac bifurcation there was seen a definite stricture area but the stone had escaped. The stone was found in the broad ligament region and was easily pushed back to the upper stricture area but could not be brought through this area into the more dilated portion of the ureter above the stricture until we made a ureterotomy opening above the stricture and dilated with Hegar dilators, from sizes 5 to 8. Each dilator hung definitely at the stricture area. After this dilatation the stone was easily pressed up through the stricture and out of the 1 centimeter incision. A No. 6 Hegar dilator was passed all the way to the bladder to dilate the stricture area in the broad ligament region. The operation was done under laughing-gas and was finished in 20 minutes, causing only moderate shock. The patient had an output of 400 cubic centimeters of bloody urine during the first 24 hours after operation but she failed to rally and had much nausea. During the second 24 hours she secreted only 300 cubic centimeters and died at noon of that day, being perfectly conscious to the last. This was probably a case of bilateral ureteral stricture in which the uninvestigated kidney was too damaged to carry the patient through after relieving the obstruction on the stone side.

CASE 9. Mrs. McD., age 33, referred by H. A. Fowler of Washington, in June, 1917. First childbirth 10 years ago, a forceps delivery followed by bilateral phlebitis. In bed with this 2 months and then developed an attack of pain through the left hip region which her husband (a physician) thought was due to the passing of a renal calculus. The pain ceased after a hypodermic of morphine and, it was supposed the calculus had passed. The urine was clear at this time. Within the next year or two she had several similar attacks and then they ceased for 6 or 7 years. About 2 years ago she was in bed for 3 weeks with an attack of illness with fever, but no pain. The urine then showed blood and pus. She went to Philadelphia after this attack and Dr. Pancoast found two ureteral stones by X-ray. Dr. Keene verified this, saying the lower stone was within two inches of the bladder. Dr. Fowler verified these findings and wrote, "that in the first plate we made, the two shadows were touching each other. In some later plates the upper shadow had moved upward and was separated considerably from the lower shadow. It would seem that the large upper stone moves up and down in the ureter and is not fixed as the lower one appears to be."

My examination revealed tenderness in both broad ligament regions on palpating the ureters. What seemed to be a small stone was easily palpated about 3 centimeters from the bladder on the left side. Investigation of the right side showed a definite stricture 3 centimeters above the bladder and the reaction from this examination kept the patient ill for a week. Investigation of the left side resulted in obstruction to the X-ray catheter 3 to 4 centimeters above the bladder. An attempt to inject the kidney and upper ureter with thorium resulted in much pain in the lower ureter after 1 to 2 cubic centimeters entered the ureter. Note the upper shadow (thorium) and the small amount of thorium which has run back into the bladder. (Fig. 13.) Operation revealed but the one small stone wedging the end of the catheter. This was encased in a broad ligament stricture and there was a second dense stricture at the iliac gland region, which had trapped the thorium, caused the intense ureter pain, and resulted in the upper large shadow taken to be a second stone. The stone was removed (see Fig. 16), both strictures were well dilated, the upper ureter was followed to the kidney pelvis with negative results, X-ray was taken during convalescence with negative results. The patient wrote three months later: "I have never been as well in my life, and have gained 25 pounds."

CASE 10. This patient first seen March 24, 1909, when she was almost exsanguinated from hæmorrhage from the right kidney. Nephrotomy March 26, draining an acute staphylococcus aureus pyelonephritis kidney, and control of bleeding by a square catgut suture tied about a gushing point of hæmorrhage situated in the pelvis immediately beneath a papilla in the upper pole. The patient had always suffered with tonsillitis, having had an acute attack three weeks before the acute hæmorrhage.

Six months later, discovery of two strictures in the right ureter, one in the broad ligament region and one in the iliac gland region. Right hydronephrosis of 15 cubic centimeters. One year after the operation, discovery of two strictures in the left ureter and a left hydronephrosis of 30 cubic centimeters with staphylococcus aureus infection. After dilatation of the strictures, the patient gained in weight from 117 pounds before the operation to 164 pounds and appeared to be in excellent health although the infection persisted. In December, 1914, I removed the large ureteral stone (Fig. 18, *d*) and made a wide dilatation of the right ureteral strictures. X-rays by Dr. Baetjer on November 26, 1910, were negative for stone on either side. On December 29, 1917, this patient again had signs of obstruction on the right side. Figure 14 was taken. Catheterization with wax-tipped bougie gave scratch marks, and the stone at the pelveo-ureteral junction was evidently loosened, as the patient became comfortable after the examination and her temperature of 103° dropped to normal. Phenolsulphonephthalein injected into the vein yielded color reaction from the left side, collected through the bladder, in 8 minutes and from the right side through the catheter in 20 minutes. In one-half hour the left side secreted 27 per cent and the right side 3 per cent. Later investiga-

tion of the left side with a 4 millimeter wax bulb catheter showed the strictures well open, the kidney pelvis to have shrunken from 30 to 10 cubic centimeters and a staphylococcus infection still present, but without leucocytes (see Fig. 15). The patient developed a severe attack on January 11, 1918, and right nephrectomy was done January 12. The large stone seen blocking the upper ureter in Figure 14 had slipped down and become wedged a short distance above the pelvic brim. The ureter was tied and cut below this stone. Most of the stones in the kidney were extruded while removing the necrotic adherent kidney and they were arranged for this photographing (Fig. 15) as nearly as possible in their original positions seen in Figure 14.

CASE 11. Patient, age 47, had passed a navy-bean-sized ureteral stone 5 years previously. Complained chiefly of pain in the left flank and pressure in the rectum. Failure of catheter to go beyond the pelvic brim region at first examination. Successful catheterization at all later attempts and dilatation of a stricture just below the pelvic brim with the wax-bulb. Rapid shrinkage of pelvis of the kidney from 28 to 10 cubic centimeters and relief of symptoms. Observation 5 months later; pelvis of kidney held 10 cubic centimeters. (Fig. 19.)

RECURRENCE OF STONE IN THE KIDNEY[1]

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THE recurrence of a condition for which a surgical operation has been performed is an important matter and merits serious consideration. The publication, in 1915, by Cabot and Crabtree (1) of a study of end-results in operations for kidney and ureteral stone, performed at the Massachusetts General Hospital for a period of eight years previous to January 1, 1914, was somewhat startling. In this it was shown that 49 per cent of the cases suffering from kidney stone and 29 per cent of those suffering from ureteral stone recurred. In 1917 Braasch (2) and W. J. Mayo (3) published a review of 450 cases at the Mayo Clinic operated upon for nephrolithiasis, and from a careful analysis of these cases the recurrences were found to be slightly less than 10 per cent. The question of recurrence of stone in the kidney was brought somewhat forcibly to my own attention by having four cases under treatment at the same time. These happen to be the only cases in my practice that have come back, but there were doubtless others from which I have not heard. In view of the two very large series referred to above, my individual statistics would hardly add much to the subject. However, as each of my cases shows a different type of recurrence, following a different operation, the histories themselves should be of interest.

In dealing with stone in the kidney, I have followed Brewer (4) in dividing my cases into two groups: one in which the stone was apparently the primary condition; and the second where the infection of the kidney was apparently the primary and predominating element. In the first case the removal of the stone was the indication; in the second the cure of the infection, which would usually mean the removal of the kidney, as the infection is ordinarily too advanced, and the alteration and destruction of the kidney too permanent, to hold out much hope of improvement from any form of conservative treatment. Whether this simple classification meets the condition, further investigation must prove.

There can be no question about the soundness of the three principles of treatment laid down by Schede (5) when he states that the object of treatment is, in the first place, to remove a formed calculus; in the second place, to limit the injury thereby produced as far as possible; and in the third place, to protect the patient against a return of the trouble. The first two have been amply met by the refinements of modern technique, but the third has apparently received very little attention. Previous to the publication of Cabot and Crabtree's paper, there seems to have been no systematic effort to determine whether the trouble returned or not.

It is not the purpose of this paper to enter into an exhaustive discussion of any part of the subject, but simply to use the cases reported as a text for comment.

The cause of formation of stone. In order to prevent a recurrence, it would be necessary

[1] Read before the Southern Surgical Association, St. Augustine, December 18–20, 1917.

to understand why stones form in the first place. Professor Schede (5) described the formation of calculus as it has been usually understood, commencing with a nucleus of some sort and the deposit being made in concentric layers. He speaks of an organic framework demonstrated by Ebstein, of the investigations of Moritz, which showed that this organic framework was present in all urinary crystals, but concluded that the quantity of this organic matter may be a factor. He also thinks that the composition of the urine, retention, geographical situation, customs and habits, and period of life, are important. On the other hand Kelly and Burnam (6) state: "The essential conditions which lead to stone formation are imperfectly understood. Age, sex, habits, diet—none of these seem to play a great part. The stones which are found in the kidney are composed of substances normally present in the urine. The problem to determine is why these salts are precipitated into stone in some cases and not in others." In reference to nucleus they state: "It has been suggested again and again that foreign elements in the urine, such as bacteria, blood-clots, or shreds of tissue, may furnish the nuceli on which stones are built. Numerous cases are on record where bacteria, blood-clots, etc., have been found in the nuclei of stones. Nevertheless such findings are the exception." Barker (7) defines a renal calculus as "the formation in the pelvis of the kidney or in the kidney itself of calculi through the deposition of solid substance from the urine, usually deposited upon some organic nucleus"; and in reference to etiology, "many studies have been undertaken to determine the cause of stone formation in the pelvis of the kidney, but the exact pathogenesis is still *far from clear.*"

The effect of any general treatment directed to the prevention of stone formation. The treatment advised for lithiasis is well illustrated by the article on this subject in Forchheimer's *Therapeusis*, by F. S. Meara (8), who gives many directions concerning exercise, alcohol, water and diet, and in reference to the latter describes various diets depending on the composition of the stone. This is somewhat confused by the fact that the majority of stones are of mixed formation; and he is then forced to quote Klemperer who says: "The prophylaxis of renal calculus lies in the mixed diet dictated by nature." I have had no experience in dieting to prevent stone or its recurrence, but in one of the cases which I report, the patient was directed to drink large quantities of water which he did religiously; and notwithstanding this he had two recurrences. It would thus appear that we have at the present time no definite method of combating stone formation.

The rôle played by infection. The case of Mrs. R. C. A., which I report, would appear to be one of a long-standing infe tion with secondary stone formation. Int ction, I believe, will have to be considered as very important in considering stone formation and its recurrence. In the thirty cases of stone which were chemically investigated by Dr. G. L. Gordon and reported by Kelly and Burnam (6), it is stated: "It is equally apparent that in mixed stones the phosphates ultimately predominate." The deposition of phosphates is certainly in the vast majority of cases associated with infection. This is a matter of common observation and is due to the resultant change in the reaction in the urine. It is now generally accepted that infection of the kidney is hæmatogenous in origin, the kidney being one of the organs through which bacteria are excreted. It would appear that the alterations in the kidney as the result of infection may be responsible primarily for certain stone formations, and in other cases the presence of a stone may be the predisposing cause of an infection, which will be the cause of much of the symptomatology, and certainly of the destructive action on the kidneys. Mayo (3) states that the type in which recurrence is most apt to occur is in "persons having large and branched stones located in a hopelessly damaged and infected kidney in which a conservative operation has been performed"; and in cases where it is necessary to conserve the kidney he lays great stress on the method of drainage. This, of course, is done to overcome infection and prevent pocketing. In one of the cases which I report an attempt was made to conserve the kidney because the functional

test showed that the affected kidney had a good function notwithstanding the presence of stone and infection. This was confirmed by incision and inspection of the kidney cortex at the time of operation. There was no recurrence in the kidney operated on; but a prompt recurrence in the kidney of the opposite side.

The anatomical cause. Frequent mention is made of the fact that where stones recur, they recur in the same location in which they were first found. In one of the cases reported by me there were two recurrences in identically the same location following two operations.

Effect of the type of operation. No improvement can be made on the rules la' down by W. J. Mayo (3). Notwithstand ıg this, however, one of the cases reporte by me showed a prompt recurrence in the opposite k:dney after a nephrectomy, in the same kidney after a pyelotomy, and none in the kidney on which a nephrotomy was done but prompt recurrence in the opposite kidney.

Recurrence is evidently more frequent than supposed. This is due to the fact that until recently methods of determining recurrence have not been exact and also to the optimism of surgeons who after they have operated on a case are convinced that the patient is entirely well and pay no attention to his complaints. The time has about come now, however, when a good many of these cases that have been operated on for kidney stone are beginning to come back. It is to be hoped that these cases will be carefully studied to determine why they complain and if the stone has recurred. Cabot and Crabtree have established as the standard of cure a negative physical examination, as far as the urinary tract is concerned, a urine that is normal on chemical and microscopic examination, and a negative X-ray. It would appear to me, as has been suggested by Braasch, that the presence of blood and pus in the urine may be the evidence of a pyelitis which had never been cured and which may have been the causative factor of the pre-existing stone. It would hardly be fair to count this as an evidence of recurrence.

Patients may have stone and still be in comparative good health, even where there has been a recurrence. This is evidenced by two of the cases reported by me. In one where a nephrectomy had been done and a stone had recurred in the opposite side, the patient had a large quantity of pus, diminished kidney function, and some œdema and general bad health. She has been treated with various urinary antiseptics and irrigations of the pelvis of the kidney. The kidney function has not markedly improved, and pus varies in amount, but œdema has disappeared and the patient is feeling comparatively well. In the other case a recurrence in the opposite kidney followed a nephrotomy and drainage, and was either preceded or followed by a severe infection attended by fever, chills, and emaciation. This patient gradually improved under treatment carried out partly by myself and partly by her attending physician; has gained about 30 pounds in weight; has only slight frequency of urination; and suffers no pain or discomfort in the region of the kidney. She came to see me to tell me that she was entirely well, and yet the X-ray plate showed four stones in the kidney.

CONCLUSIONS

Notwithstanding all that has been said or can be said, the conclusions of Cabot and Crabtree, in my opinion, are thoroughly sound. I trust that further experience will enable us to improve our results, but at the present time this is as far as we can go. They say: "On the basis of these cases we can only say to the patient that the risk of operation is small; that the danger of progressive destruction of the kidney by the stone, if it is left, is considerable; that it depends somewhat upon the age, undoubtedly somewhat upon the method of operation and the skill with which it is carried out, but clearly upon an entirely unknown factor — the liability or the ability of that particular kidney to form concretions."

CASE 1. Mrs. R. C. A. was operated upon June 7, 1907, for a right salpingitis and removal of appendix. About a month after leaving the hospital she had a chill followed by fever and violent pain in left side. Shortly afterwards she passed a stone and had relief of symptoms. In March, 1908, nine months later, she was complaining of pain in lower abdomen, epigastrium and right shoulder, and also

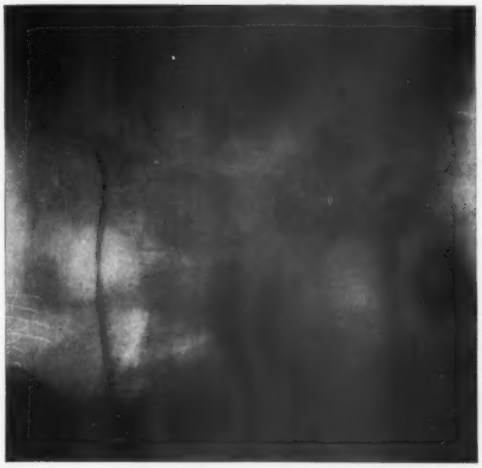

Fig. 1. Branched stone in right kidney of Case 1, previous to operation.

weakness of bladder. Examination of the urine showed pus and blood in the urine. In November, 1908, the urine had become alkaline. In July, 1910, she aborted at 3½ months.

At times there was a faintly acid urine reaction and the amount of pus and blood varied. Several X-ray plates were negative for stone. From February, 1911, to February, 1912, the patient was comparatively comfortable. Catheterization of both ureters in May, 1912, showed a few pus cells from the left ureter; a great number from the right.

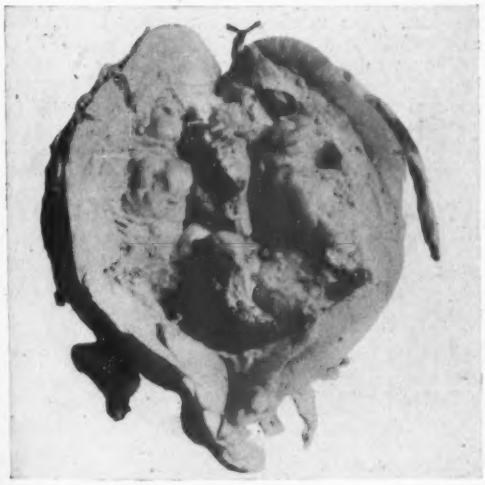

Fig. 2. Right kidney removed from Case 1.

Fig. 3. Recurrence of stone in opposite kidney after nephrectomy. Case 1.

In September, 1915, the patient reported a continuation of pain in the back and bladder disturbance, and an examination of the urine showed considerable pus and few red cells. Cystoscopic examination showed congestion and œdema of the base of the bladder. The flow from the right side was scanty and cloudy in comparison with left. The right side showed pus and colon bacilli; the left side negative. Following this, four lavage treatments were given the right kidney. In October, 1915, leaded catheters were introduced into both ureters up to the kidney pelvis and an X-ray plate made before and after collargol injections.

X-ray plates showed a normal left kidney, and in the right kidney an enormous stone filling the pelvis and projecting into the calyces. Five days later these findings were confirmed by a second X-ray (Fig. 1).

In testing the kidney function the phenolsulphonephthalein was injected intravenously, and normally should show about 15 per cent in 15 minutes. In this test the right kidney showed only 2 per cent and the left kidney 20 per cent. The destruction of the right kidney substance was well shown in the subsequent operation. Catheterization of the ureters gave the same findings as at the previous examination; right kidney, pus and colon bacilli; left kidney negative.

On October 21, 1915, a right nephrectomy was done. The kidney was much enlarged and adherent. The ureter was divided as close to the bladder as possible.

Gross examination showed all functionating structure practically destroyed, the pelvis dilated and full

Fig. 4. Branched stone in right kidney with considerable dilatation of right pelvis. Case 2.

Fig. 5. Recurrence in opposite kidney after a nephrotomy and drainage.

of pus and stones. The major portion of the stone collection was in the pelvis with numerous branches extending into the calyces. The stone was soft and showed characteristic fractures. The lining membrane of the pelvis was practically destroyed and the pelvic fat increased. Analysis of stones: calcium phosphate (Fig. 2).

Twenty days later the patient complained of pain in the left kidney and a large amount of pus in the urine. A cystoscopic examination made five weeks after operation showed the left kidney negative but pus was seen oozing from the stump of the right ureter. A catheter was inserted and the stump was washed out with formaldehyde solution.

Ten days later the left kidney showed on catheterization a few colon bacilli and epithelium but no pus. The stump of the right ureter was still discharging pus. A plug of pus was washed out by irrigating with formaldehyde solution and 2 cubic centimeters of pure carbolic acid injected.

In July, 1916, the patient complained of a gnawing feeling in the left kidney and urine from the bladder showed some pus.

In January, 1917, the urine contained blood and the patient had a slightly uncomfortable feeling about the bladder but no severe pain.

On February 13, 1917, a cystoscopic examination was made and the stump of the right ureter found obliterated. The left pelvis was dilated, the ureter was capacious and admitted a No. 11 Garceau catheter. The urine contained pus, blood, and colon bacilli in abundance.

The next day the X-ray plate showed two stones in left kidney. The recurrence was demonstrated one year and four months after nephrectomy of opposite kidney (Fig. 3).

The stone in this kidney has never been removed. The pelvis has been irrigated at intervals with

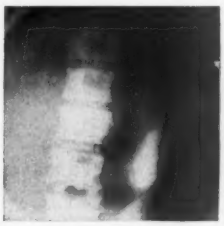

Fig. 6.

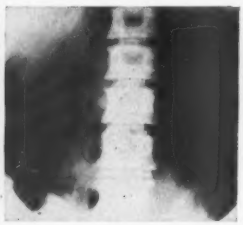

Fig. 7.

Fig. 8.

Fig. 6. Large stone in left pelvis. Right kidney and ureter and bladder clear. Case 3.

Fig. 7. Left pelvis clear. Case 3.

Fig. 8. Large concretion in right ureter about 4 inches from bladder. Case 3.

15 per cent collargol and the patient has been taking various urinary antiseptics. She remains in reasonably good health and has very little urinary disturbance. Her kidney function ranges around 50 per cent in two hours.

CASE 2. Mrs. L. B. seen first November 23, 1916, at which time she complained of very frequent and burning urination. These symptoms commenced five years ago with an attack of fever, pronounced typhoid. She at first had a stinging on urination and later frequent passage of a small amount of urine. After several years she began to have periods in which her symptoms became very much exaggerated and for the past two years she has become steadily worse, until now she suffers constantly and is unable to go about or attend to her work. During the day she voids at intervals of from 5 to 20 minutes and is up and down all night. She now has marked tenesmus but otherwise no pain except an aching over the sacral region.

Cystoscopic examination showed a marked inflammation of the base of the bladder, particularly associated with the right ureteral orifice, the left ureteral orifice was normal in appearance.

Urine collected from the right kidney showed a large amount of pus; from the left kidney it was negative. Cultures from the right kidney showed a growth of pure colon bacilli, from the left kidney no growth.

X-ray examination showed a branched stone in the right kidney with considerable dilatation of the right pelvis (Fig. 4). Capacity: right pelvis 29 cubic centimeters, left pelvis 10 cubic centimeters.

Function: right kidney 10 per cent in 20 minutes; left kidney 25 per cent in 20 minutes.

She was operated upon on December 4, 1916, and the right kidney was found enlarged and adherent. It was bisected with wire and the stone easily located and removed. The cortex of the kidney was thinned, but the parenchyma appeared worth saving. The kidney pelvis was drained with rubber drainage tube. Immediately following the operation the patient developed a temperature which continued irregularly for a period of several months.

On December 28, 1916, twenty-four days after operation, a cystoscopic examination with catheterization of ureters showed as follows: Right kidney: (one operated upon) few pus cells, no bacteria. Left kidney: (previously negative) large amount of pus and colon bacilli. The left kidney pelvis was subsequently irrigated without improvement and in January, 1917, an X-ray showed 4 stones in the left kidney. These stones apparently formed in a month's time (Fig. 5).

Some interesting points in this case are as follows: On December 2, 1916, when the first examinations were made, the capacity of the right kidney as tested was 29 cubic centimeters and of the left kidney 10 cubic centimeters and the function of the right kidney 10 per cent in 20 minutes, of the left 25 per cent in 20 minutes.

On January 30, 1917, a little over 8 weeks later, the left pelvis had a capacity of 45 cubic centimeters and the left kidney function was 9 per cent in 20 minutes.

Fig. 9. Horseshoe kidney. Left pelvis full of mushy material, right pelvis empty. Small soft concretion in left ureter about middle. Large stone in right ureter about 4 inches from bladder. Case 3.

The left kidney has not been operated upon. The patient was seen about 2 months ago and had gained about 30 pounds and complained of comparatively little urinary discomfort.

CASE 3. J. A. G. seen first November 8, 1916, when he stated that for years he had suffered with pain in the left kidney and marked bladder disturbance. On July 4, 1916, he was operated upon at Virginia Hospital and two stones were removed from the left ureter. The X-ray at that time showed no stones on the right side.

He left the hospital in August and after going home had two attacks of kidney colic in the left side and three in the right side, and had had constant bladder disturbance and more or less constant pain in the back.

Three weeks before, after a severe right sided attack, he passed three stones, and when seen he was in the midst of an attack on the right side.

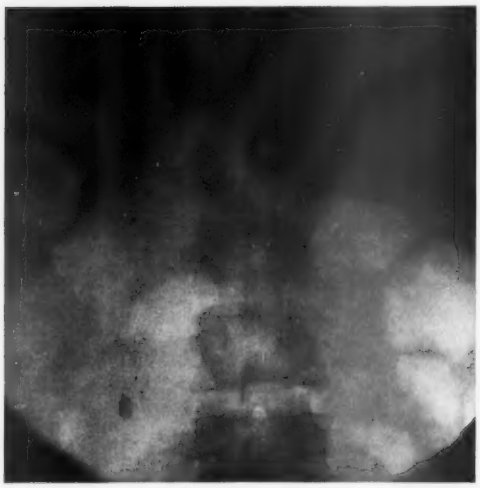

Fig. 10. Recurrence of stone at site of previous removal. Case 4.

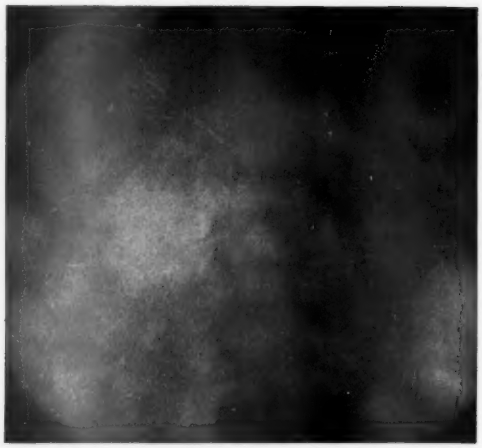

Fig. 11. Second recurrence of stone at site of previous removal. Case 4.

One week later an X-ray plate showed the following: A large stone in the pelvis of the left kidney, 2 small stones in the right ureter about 4 inches below the kidney, and an almond sized stone in the bladder.

The stone in the bladder was crushed with forceps and removed through a cystoscope, a wax-tipped catheter was passed to the point of the shadow in the right ureter and returned with scratches. In three subsequent cystoscopies, the right ureter was dilated, the orifice stretched with forceps and glycerine injected, and the stricture in the left ureter was also dilated. After this the bladder symptoms cleared up entirely and the patient had no trouble, until December 28, 1916, when he again had an attack of pain in the left side. The patient subsequently suffered considerable pain and in spite of every effort at medication, the urine remained persistently alkaline. An X-ray, on February 1, 1917, showed the right kidney, ureter and bladder all clear; and on the left side a large stone in the left pelvis which had definitely increased in size (Fig. 6).

On February 19, 1917, through a nephrotomy opening, a large collection of stones embedded in granular material and enclosed in a membrane was removed from the pelvis of left kidney and the kidney pelvis drained. Analysis of stones: ammonium and magnesium phosphate.

While still in the hospital, about three weeks after the operation, the patient began to have pain in the right side and finally passed a soft stone.

On March 30, 1917, the right kidney shut down completely, there was no bladder urine, but the left kidney was excreting freely from the drainage wound in the back. This condition continued and on April 3, 1917, an X-ray showed the left urinary tract clear (Fig. 7), but a concretion about the size of a peach stone plugging the right ureter about 4 inches from the bladder, which accounted for the anuria (Fig. 8). On the same day he was cystoscoped and a catheter stiffened with wire forced through the concretion, which was quite soft, and the tension relieved. This was done once afterwards.

On April 19, a right nephrotomy was done to relieve blockage of kidney. On May 2, 1917, the patient died and the following note was made of autopsy:

Autopsy done and entire urinary tract on both sides removed (Fig. 9). The kidney and ureters were very adherent. The lower poles of the kidney were connected across the vertebral column by a band of renal substance about one and one-quarter inches wide and one-eighth inch thick, making a complete horseshoe; the aorta lying *on top* of this band. The pelves and ureters were entirely distinct throughout. The pelves entered the kidneys anteriorly, the blood supply going in behind and laterally. The left pelvis was full of mushy semi-membranous material, the right pelvis empty. There was a small soft concretion in the left ureter about the middle. There was a large stone in the right ureter about 4 inches from the bladder. This stone was broken in two places and contained a hole which may have been the point at which the catheter passed through it. There was no stricture in the left ureter. The right ureter was much dilated. The base of the bladder was inflamed. There were nephrotomy openings in both kidneys. The left kidney was markedly lobulated.

CASE 4. H. I., seen first December 19, 1911, when he stated that four weeks previously, after wrestling, he was seized with an attack of pain in the left side and bloody urine. From this he gradually improved,

until ten days before entering the hospital he strained himself holding a frightened horse and this caused a recurrence and bloody urine. The pain commenced near the back bone in the loin and ran down to the testicle which retracts. The urine showed blood. The X-ray disclosed a small stone in the left ureter just below the kidney pelvis.

On December 29, 1911, the stone was removed by a pyelotomy, milking the stone back into the kidney pelvis. After this the patient made an uneventful recovery and remained well until November 2, 1914, when he complained of a dull throbbing pain in the right iliac region with frequent urination. He had been drinking a large quantity of water by direction.

Examination of the urine showed a few clumps of pus and a few blood cells and amorphous urates.

The cystoscopic examination was negative except that there was blood on both sides, which was probably traumatic, and a small amount of pus from both sides. The X-ray plate was negative.

On July 25, 1916, the patient reported that he had had several attacks of pain on the left side and bloody urine. The X-ray plate showed a small stone at the exact site of the previous stone and of the same size (Fig. 10). On July 31, 1916, a pyelotomy was done and stone removed. Analysis of stone: magnesium phosphate.

On February 1, 1917, the patient complained of a pain in the left side of the back and the urine showed blood. On February 13, 1917, a cystoscopic examination was made and an obstruction encountered in the left ureter 25 centimeters from the bladder. A waxed-tipped catheter showed scratches.

A roentgenogram showed a stone of the same size and in the same location as formerly (Fig. 11). The ureter was dilated and glycerine injected twice but so far no stone has passed.

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THE MANAGEMENT OF SUBPARIETAL INJURIES OF THE KIDNEY

With Report of Three Cases[1]

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SUBPARIETAL injuries of the kidney vary much in severity, and may consist of contusions, lacerations or rupture. The injuries may be simple, that is, confined to the kidney alone, or complicated by injury to the blood-vessels, ureter, peritoneum or other adjacent structures, or to any other tissue or structure of the body. As kidney injuries are due to such a variety of traumata, the associated lesions are not subject to classification, but must be considered individually.

No large collection of kidney injuries is likely to occur in the practice of any one surgeon, but the literature contains many isolated case reports, numerous small series of cases, and several tabulated collections of large numbers of cases, with results obtained by various methods of treatment.

For the purpose of this paper it has not been deemed necessary to collect all the reported cases as this has been done repeatedly, and the figures have been brought up to date as recently as October, 1916, by Bugbee (1).

We prefer to discuss the subject from materials before us, modified by more recent advances in surgical technique, kidney functioning tests, and safer anæsthesia.

Hæmaturia, pain and tenderness over the kidney, the development of a tumor about the kidney, together with varying degrees of shock and collapse, following a history of trauma to the loin, indicate an injury of gravity to the kidney.

As many cases are recorded where shock and severe pain were absent or delayed, we should be carefully on guard when trauma is followed by hæmaturia, and should keep such

[1]Read before the Southern Surgical Association, St. Augustine, Florida, December 18, 1917.

a patient perfectly quiet and under constant observation until the nature of the injury is determined.

Expectant treatment, early exploration, and late operative treatment have been the plans pursued in dealing with these injuries.

Expectant treatment. Michelson (2), from Riga Hospital for twenty years preceding 1911, reports 30 cases of rupture of the kidney all of which were treated expectantly, with only 3 deaths, 10 per cent, and in all the fatal cases there were severe complicating injuries: (a) compound fracture of the leg, fracture of the forearm, multiple fracture of ribs; (b) rupture of liver, multiple fracture of ribs; (c) fracture of forearm, multiple fracture of ribs, pneumonia.

Ponomareff (3), from Municipal Hospital Obishoff, St. Petersburg, 1898-1912, reports 57 cases of ruptured kidney with the following results: Three cases left the hospital untreated and were lost sight of; 3 died as a result of complicating injuries; 43 recovered under expectant treatment; 8 recovered under operative treatment.

From these statistics, expectant or non-operative treatment in the uncomplicated cases would seem to be without mortality. Watson (4), however, reports a mortality of 27 per cent under expectant treatment in 237 collected cases.

The statistics of Michelson and Ponomareff, which are widely quoted, have given "expectant treatment" a status to which, in my judgment, it is not entitled. Furthermore, of the large number of cases reported by them as ruptured kidneys, unconfirmed by operation or autopsy, some must have been injuries of much less severity.

Concerning this plan of treatment, Neilson (5) says: "So-called expectant treatment is permissible only in cases in which local symptoms are insignificant, constitutional symptoms are absent, and slight hæmaturia alone directs attention to the probability of renal injury." He further claims that "of this type there are not a few, and to their almost invariable recovery can be given the largest share of credit due to the non-surgical treatment." This opinion seems to me sound and gives to expectant treatment its proper status. I have not found any pathological studies which tell us exactly what happens to the injured kidney when it bleeds for a few days and stops. Presumably it is contused or a small blood-vessel communicating with the pelvis is ruptured.

Except in those cases in which delay is demanded by reason of severe shock or complicating injuries, no just claim can be made in favor of expectant or non-surgical treatment, unless it be established that exploration of the injured kidney is inherently dangerous or more dangerous than awaiting developments. With our present kidney functional tests, our easy means of demonstrating the presence of a second functionating kidney, and our safer methods of anæsthesia, the claim for such inherent or comparative danger cannot be maintained. This is particularly true when we remember that the late developments too often are anuria, hæmorrhage, or sepsis.

That apparent recovery under expectant treatment may be followed by remote chronic illness due to the original renal injury is borne out by three of Bugbee's cases (1).

In Case 4 of his series a tumor of the left kidney, with dark colored, purulent urine, with very little functional activity, was found in a patient who received a kick in the side thirteen years previously, for which injury he received expectant treatment in a hospital for three weeks. In Case 6 the patient presented symptoms and findings diagnosed as organized hæmatoma in the lower pole of left kidney from an injury received four years previously, since which time there had been tenderness, with attacks of dull, aching pain over the left kidney. In Case 8 more or less constant dull pain was present in the right kidney region for eleven years following a fall from a pole, which was associated with hæmaturia for four days. There was present a movable right kidney with deficiency in functionating. A pyelogram showed a shadow which was presumed to be a cicatrix from a healed laceration of the kidney. Kelly and Burnam mention that stone formation and tuberculosis have been observed as late sequelæ of injured kidneys treated expectantly.

Fig. 1. Kidney removed from Case 3.

Fig. 2. Extensive necrotic areas which dip down deeply into the kidney substance some distance below the line of rupture.

Early exploration. All operations upon injured kidneys must be in the nature of explorations, as it is impossible, without inspection, to tell the extent or character of the injury which the kidney has sustained. With early exploration, conservative treatment of the injured organ may be successfully carried out in a large number of cases in which it would probably fail if attempted later.

In a certain number of instances the lacerated or ruptured kidney may be treated by suture with entire success. This is the ideal method in suitable cases, but obviously it cannot be carried out in late operations when necrosis and infection have been added to the original injury.

Watson (4) has collected 10 cases of suture of the ruptured kidney without fatality. Connell (6) has added 3 personal cases successfully sutured, and has collected 16 cases without a death, and with only 2 failures, one case requiring secondary nephrectomy and one being followed by a urinary fistula. Connell's cases were operated on early, one on the morning of the second day, one on the afternoon of the day following the injury, and one thirty-six hours after the receipt of the injury. A fourth case of rupture, operated on on the tenth day, required nephrectomy on account of infection and gangrene.

Packing and drainage of the ruptured kidney has shown a very favorable mortality. In Watson's series, 107 cases were so treated with a mortality of 8.5 per cent, as compared with 132 nephrectomies with a mortality of 22.5 per cent.

In cases treated by packing the convalescence is prolonged, the final outcome is always in doubt, and the patient is in constant danger from secondary hæmorrhage. One of Neilson's cases died from secondary hæmorrhage on the thirteenth day after operation, upon removal of the last of the gauze pack. These drawbacks act as a bar to too great conservatism in dealing with an extensively lacerated kidney unless the remaining organ is distinctly incompetent.

The mortality of 22.5 per cent for nephrectomy, as set down by Watson, in 1903, is perhaps much higher than obtains at the present time or should obtain in the future.

This mortality is dependent upon the general condition of the patient, upon the competency of the remaining kidney, and upon the character of the anæsthetic. Unfortunately, accidents befall the vigorous and

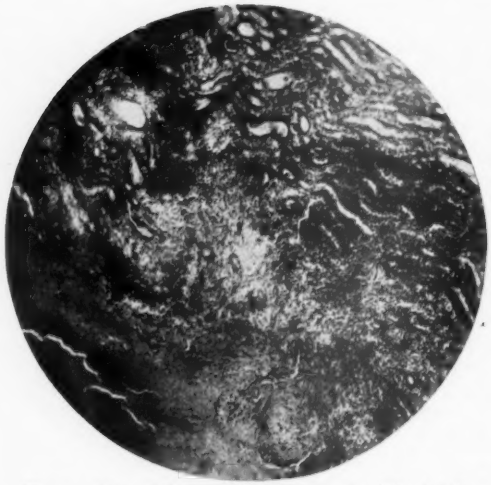

Fig. 3. Line of demarcation between healthy tubules and areas of complete necrosis.

healthy as well as those with organic disease, hence a certain mortality will always obtain.

With proper investigation of the condition of the remaining kidney, with due regard to the general condition of the patient, and with the use of nitrous oxide oxygen anæsthesia, few fatalities should result.

That removal of the ruptured kidney is not unduly hazardous is attested by the large number of successful cases in which the above precautions have been taken. For example, Gibson (7) reports 4 successful cases in children; Boland (8) reports 2 successful cases; my own case here reported recovered; Connell's case was successful, as were also large numbers of similar cases on record.

Late operation. It is often the case that surgical diseases and injuries do not reach the surgeon until expectant treatment has been tried and failed. In the case of the damaged kidney this means that the local and constitutional symptoms have become aggravated and that the patient reaches the operating room in worse condition than if he had been subjected to early exploration. Late operation, in the presence of a ruptured kidney, usually means nephrectomy, though packing for control of hæmorrhage and prolonged drainage for the relief of sepsis will sometimes prove successful.

SUMMARY

Taking into consideration the high mortality and general uncertainty of expectant treatment, and the obvious limitations of conservatism in late operations, early exploration is the proper and logical method of proceeding, and its advantages may be summarized as follows:

1. The danger of exploration, in properly managed cases, is slight and is not to be compared to the risks of delay.
2. The nature and extent of the injury may be definitely and promptly determined.
3. Appropriate measures may be promptly employed for the control of hæmorrhage, to guard against infection, and to provide for drainage.
4. In certain favorable cases suture of the ruptured kidney may be successfully carried out, while in other instances the kidney may be saved by packing and drainage.
5. A hopelessly damaged kidney may be promptly removed, thereby shortening convalescence and restoring the patient to health in the briefest possible time.

REPORT OF CASES

Three cases of subparietal injury to the kidney have come under my observation, two of them in my own practice and one in the care of my associate, B. S. Lester, with whom I saw the case in consultation.

Two of the cases were ruptures, and one I have classed as a contusion or slight laceration of the kidney, complicated by fracture of the right iliac crest, fracture of the left femoral neck, and multiple fracture of ribs.

CASE 1. White male, age 35, fell from a pole, a distance of about twenty-five feet, and was brought to the hospital suffering from severe shock. Examination showed that he had sustained a fracture of the neck of the left femur, a fracture of the right iliac crest and fracture of several ribs on the right side. He was catheterized and a small amount of bloody urine was withdrawn from the bladder. After he had reacted somewhat from shock, in order to determine the source of the bloody urine, he was anæsthetized with nitrous oxide, and cystoscoped. The blood was found to come from the right kidney, while the left was found to be functionating normally. On account of the extent of the complicating injuries, exploration of the kidney could not be safely undertaken. For four days the urine was very scant and bloody, but after that time the

amount became normal, the blood cleared up, and the kidney gave no further evidence of injury. No tumor developed in the loin, and I have classed the case as one of contusion or slight laceration.

CASE 2. Rupture of right kidney; death without operation at end of twenty hours.

This case was seen in consultation with B. S. Lester, who has permitted me to include it with my own. A white man, age about 30, jumped from a moving train about 6 p. m., and fell, injuring his right loin. He made his way home but called the physician about 9 o'clock. He was not suffering severely, but had passed some bloody urine. He was with difficulty persuaded to go to the hospital. The following morning, the blood having continued in the urine and a tumor having appeared in the right loin and his general condition having become worse, rupture of the right kidney was suspected, and he was cystoscoped for the purpose of determining the source of the blood and the condition of the other kidney. The right kidney was found to be bleeding, while the left was functionating normally. The diagnosis of rupture of the right kidney was made and arrangements were made for operation. Before these could be perfected the patient became collapsed and pulseless, and died before any operation could be undertaken.

CASE 3. White female, age 14, was run over by an automobile on August 16, 1917. According to the history she was severely shocked and suffered from nausea and vomiting. She had great soreness in the left side of the abdomen, especially over the left kidney. Hæmaturia was present for three days, subsided for a day, and then returned. She was admitted to St. Vincent's Hospital on August 21, six days after the receipt of the injury, where I first saw her.

Examination showed a temperature of 102°, pulse 112, a palpable mass in the region of the left kidney, which was extremely tender, leucocyte count of 9250, and bloody urine.

The following morning she was prepared for exploration. After anæsthetizing with nitrous oxide, a cystoscope was introduced and the separated urines collected. The left was bloody while that from the right was perfectly normal. Time did not permit the employment of functional tests. The diagnosis of rupture of the left kidney was made and the kidney quickly exposed.

It was found deeply lacerated and surrounded by a large clot. This completely separated the kidney from its fatty capsule. The clot was lifted out, the kidney was inspected and considered to be irreparably damaged, and was removed. One cigarette drain was used, and an uneventful recovery followed. She left the hospital, with wound completely healed, on the nineteenth day.

Reference to the three photographs which illustrate this paper, taken from Case 3, which was operated on on the seventh day after injury, show the futility of suture of the kidney after the lapse of any material length of time. Figure 1 shows the gross tearing to which the kidney was subjected. Figure 2 shows the extensive necrotic areas which dip down into the kidney substance some distance below the line of rupture. Figure 3 shows the distinct line of demarcation between the healthy kidney tubules and the areas of complete necrosis.

It is quite apparent that for kidney suture to be successful, it must follow quickly upon the receipt of the rupture, before these necrotic changes have taken place.

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THE MEDICAL PROFESSION AND THE GREAT WAR[1]

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THE Southern Surgical Association, the presidency of which your exceeding generosity most graciously conferred upon me, has for nearly a third of a century been intensely and diligently seeking to perfect methods and men in the science and art of surgery.

Each year we have come together with gladness and joy, enthusiastic in the achievements of the hour, and intent upon the advancement of our professional ability to relieve our fellow beings of their pain and disease. Since last we met the alarums of war have been sounded. Our great nation has

[1] Presidential address before the Southern Surgical Association, St. Augustine, Florida, December 11–14, 1917.

joined the embattled legions of our Allies overseas in self-immolation for the preservaton of the peace and liberties of the world. The impulses of our profession have been kindled, our responsibilities and problems have been inconceivably augmented. Some millions of our bravest and best beloved are consecrating their lives to the stupendous task of making the world free. They will be exposed to the inevitable diseases and mutilations which it will be our duty to prevent, to assuage, and to repair.

The world is bathed in blood and tears. Its peace has been devastated and destroyed with the pitilessness and terror of an Alpine glacier.

This war is a clash between the ideals of democracy and autocracy. We now know that it was inevitable. The issue is between two political and social principles, which cannot longer dwell together on the earth. Our enemies believe that might makes right; we believe that right makes might. It takes first rank with the most magnificent events in all history. It will not change maps, but individuals. It will make them free. It is portentous; it is almost sacred in its intent. When the end shall have been attained, it will lift a mighty people upon a higher plane for their development; the great nation, thrice-panoplied, that now faces the world. It knows not, that the stupendous struggle is for their liberty, as for that of all the nations on the globe. It is for this that we are sending our brothers, our sons, and ourselves to take our stand in this gigantic issue, upon the outcome of which the future of all mankind will depend.

Commercial Germany would have made a peaceful conquest of the world, but industrial Germany had no voice. Imperialistic Germany cunningly planned the most unpardonable and deliberately cruel of all wars. They would none of arbitrament. As Van Dyke said, "The Barabbas of war was preferred to the Christ of righteous judgment." Those who loved peace were forced to fight for it or give it up forever.

We must play our appointed part in the world, consecrate ourselves to our principles and policies, put aside self-seeking, distraction and the very peace which we have imagined for ourselves in order to give it unto others. The page on which the history of this most holy of wars will yet be written will be illumined with the great white light of our pure and unstained desire to benefit the cause of humanity.

Was there ever a war before where the victor desired no spoils? Should the lofty disinterestedness of our cause and the superiority of our might give us the victory, there would be no vindictiveness or economic vengeance wreaked upon our enemies. Our loftiest aims and most sacred ideals have been crystallized and formulated by that great seer, that incomparable patriot, and immortal statesman, Woodrow Wilson, Prime Minister of the World.

If our nation lives up to its own plighted word, it will gain for itself new honor and imperishable fame. If our sacrifice establishes on a big scale, and securely, those great institutions and opportunities which make men free, then the contest rises to the sublime.

Our enemies are not willing to be responsible for this war. Although inaugurating it, they disavow their initiative and summon their scientists and philosophers to prove it.

It is not the Teuton or the Oriental who is the enemy of civilization. Militarism is the enemy. From the Straits of Dover to the very gates of the Garden of Eden itself grim visaged war has raised its bloody head.

It is into this "hell of iron" that the youth and flower of American manhood must fling itself. They must join in the comradeship of arms and the exaltation of spirit with their intrepid and fearless British cousins and with the heroes of clear-eyed France, torch-bearer of the nations.

It was of a poilu that Henri Barbusse wrote:

"Each one knows that he is going to take his head, his chest, his belly, his whole body, all naked, up to the rifles pointed forward, to the shells, to the bombs piled and ready, and above all to the methodical and almost infallible machine guns, to all that is waiting for him yonder, and is now so frightfully silent, before he reaches the other soldiers that he must kill. They are not careless of

their lives, like brigands, nor blinded by passion, like savages. It is in full consciousness, as in full health and full strength, that they are massed there to hurl themselves once more into that sort of madman's part imposed on all men by the madness of the human race."

It was a manly young fellow, like one of these, who, when brought mutilated to the dressing station by the stretcher-bearers said, "I offered France my life and she took only my arms." A young English soldier mortally wounded was seen suddenly to leap into the air and with his last breath cry out: "Are we downhearted? No!"

Are the best physicians and surgeons of our country too skillful, or too gentle, to be permitted to minister to the fine fortitude of such splendid bravery? No, the faithful sons of Esculapius have never faltered! As Sir Berkeley Moynihan has said: "We are, as a profession, by intellectual descent and by solemn adoption, the heirs of the men who have made our race great and famous."

It will always be an inspiration to us to remember that the first American to carry the Stars and Stripes to our stricken Allies after the fateful April 6, 1917, was a surgeon, bearing also a Red Cross, a member of this Association, Major George W. Crile.

It is a benison to our profession, that the first officer in the uniform of our country to yield up his life was also a physician, Lieutenant Fitzpatrick, who was struck by a shell that exploded while he was standing in the door of the Washington University Base Hospital.

The personal and material sacrifices which our guild have made and are making are not equaled by any other profession or class. We rejoice in its contemplation, and take inspiration from the fact that only through the efforts of the medical profession has the prosecution of the war been possible. It would, as our distinguished Fellow, C. H. Mayo, has said, have been terminated long ago through the same causes which have terminated all wars in the past, through disease and infection.

In the momentous hours of history some individual with transcendent attributes seems to be raised up. The essential to preserving an effective fighting force is primarily vigorous and immaculate sanitation, scientific and uncompromising prophylaxis. Who could have been more opportunely fitted for this task than the man who conquered the deadly and pestilential Canal Zone—the brilliant Southern scientist and knightly soldier, Surgeon General William C. Gorgas? He has summoned about him many score of our best sanitarians, surgeons, internists and specialists who have unstintedly given of their time, knowledge and labor. He has sent nearly two thousand medical officers to our needy Allies. He has builded, equipped and manned hospitals, from 500 to 1000 beds each, in nearly one-half hundred cantonments and camps, caring for cities of from twenty to seventy-five thousand soldiers. He has organized courses of intensive special training in the great centers for his medical officers, that, in addition to the training camps for the Reserve Corps, have become the greatest and most comprehensive post-graduate courses in the world. He has dispatched base hospitals, not only for our own expeditionary forces, but out of his abundance has loaned to the other nations, and yet the manifold activities of the Surgeon General's office, while incomputable, have only begun.

The distressful epidemics that ravaged our armies in the Spanish-American War were deadlier to our soldiers than all the bullets fired in the Antilles. Preventive medicine, especially as applied to armies, has made tremendous progress. Witness our unparalleled feat of mobilizing, last year on the Mexican border; more soldiers than have bivouacked since the Civil War; more men than belonged to any one command during that sad conflict; more men than were enlisted against Spain; and instead of marking the border with lines of tombstones, we brought back the 100,000 national guardmen with a net gain of over a million pounds. There was scarcely a case of typhoid fever and the usual infectious diseases were banished as if by magic. At Chickamauga, in 1898, there were thousands of cases. During the three years of the present war the British with her millions of men engaged have only lost 292 men from typhoid fever.

Typhus fever has been denied access to the

battleground of the far-flung Western front. We will see to it that it will never gain a foothold in our army camps.

Tetanus is almost completely prevented. So far as lockjaw is concerned, the bullet is as harmless as the sting of a bee. And now from the Rockefeller Institute comes another discovery, an antitoxin for the gas bacillus—by Dr. Carrol W. Bull. You will honor him as a Southerner, and I will acclaim him as a Tennessean.

The Medical Reserve Corps now numbers nearly fifteen thousand physicians, who have volunteered and been commissioned. This very remarkable mobilization in eight months, of over one-sixth of the active practitioners in this country, has been made possible by the far-seeing and highly proficient labors of the medical section of the Council of National Defense. It is due to the patriotism and superlative organizing capacity of one of our Fellows, Franklin H. Martin, who associated with himself another of our Fellows, Frank F. Simpson, and these two with indefatigable effort, beginning nearly a year before war was declared, organized every state and rendered physicians available and effective. This is the first time our profession has been given its due meed of recognition, in being honored by representation on the Advisory Commission of the Cabinet, a recognition long merited and signalized by an appointment most felicitous.

Through the further elaborate activities of the Medical Section of the Council of National Defense and the far-reaching organization of the American Medical Association, most elaborate plans have just been perfected by the creation in each state of medical advisory boards to re-examine certain registrants in the re-classification of nine million men, which is now beginning. It is not too much to say that the physicians and surgeons were perhaps better organized and mobilized than any other newly-created fasciculus of our great structure of preparedness.

Through the endeavors of medical men, sanitation has become so perfected that the only danger to the soldier is the bullet, and if he is not killed outright the superior methods of treating war wounds deprive them of many of their dangers. The excellent work of Carrel and Dakin in putting antiseptic management of war and industrial wounds on a higher and more wonderful plane of usefulness is a contribution to humanity of stupendous moment.

If medical men have been of indispensable value in this war, who will compute the improvement in the management of every type of injury to the human body? Dr. Crile declares that "more progress has been made in the surgery of the chest and abdomen, in the treatment of wounds, of infections, of hæmorrhage and exhaustion, more knowledge has been accumulated of splints, of apparatus and of every applicable mechanism in the three brief years of war than in the past generation."

Apart from the humanitarian aspects of the war, it will be regarded, in the eyes of future generations in its end-result as has been said, as The War Beautiful. The French Revolution with all its terrors quadrupled the scope of civilization; the American Revolution with all its sufferings was of all wars the most constructive; the Civil War with its bitterness cannot now be but looked upon as essential and evolutional. One cannot be unmindful of the millions of lives already sacrificed, nor of thrice these millions, who have been wounded and maimed. In comparison we must consider the lives sacrificed in peace by preventable disease, by unnecessary industrial accidents and deaths, by enforced poverty, by the evils of alcohol, by prostitution and by wanton manslaughter. If, as the result of the supreme and essential sacrifices of this war, we necessarily or voluntarily safeguard human life—men, women, mothers and little children—the saving will exceed the waste.

Already this war has emancipated men from the slavery of alcohol—the greatest curse and blight upon humanity. The gain in food products will be incalculable. The tilling of the soil will be raised to the nth power, which will make for homebuilding. National safety will oblige essential reforms of our tenement system; our slums; of capital, that it should not get more than a reasonable and just profit; of labor, that it receive its full and fair reward. It will insure equal opportunities for women; it will signal the end of fabulous

fortunes. The wealthy classes will be quickened into keener appreciation of citizenship. Statesmen will be recruited from men of parts, instead of from politicians. In lieu of luxurious indulgence, abstemiousness will be the fashion. The creed of physical fitness will be embraced, universal military training will probably become effective, for physical reasons, if not for martial needs.

The social disease which has heretofore been considered the inevitable pestilence of armies is being fought with every imaginable agency — education, recreation, diversion, protection, isolation, prophylaxis, penalties and court-martial. Many thousands of young men will, for the first time on a wholesale plan, be taught the whole truth by all sorts of real men, and purity made a cult, a win-the-war asset. After the war the idea will permeate all strata of society and be a real understandable and livable benefaction.

It will disseminate throughout America the practice of personal hygiene by uncounted numbers of young men. The beneficent results to accrue to us and to posterity will almost make the war worth while.

When our soldiers reach France, it seems that they become exalted with the purpose of victory; they have lived the clean life and believe in it; they have been known to avoid all temptations in the great cities during furloughs. It is army experience that a sober man seldom seeks impure associations. Our American youth will learn reverence for authority, discipline, obedience—immediate and implicit. For the duration of the war the intensive high-minded instruction that will be inculcated into the minds and lives of young Americans will work a veritable physical and moral rebirth of this nation.

As the by-products of industry are the most important, so the fierce necessities of war make many collateral advancements. Great progress in many branches of manufacture has been brought about. We will of necessity make our own dyes and our own chemicals of all sorts.

To effectively educate five hundred million people, in the brotherhood of mankind, could not have been accomplished without the lessons and results of this war, costly as it is.

When the carnage has ended, the world will have drained itself well-nigh dry. Much of its best and most precious blood will be spilled. Its liquid capital will have been used up. It will be the privilege of this nation to bind up the war's wounds and to slake the white-heat of hatred; to be in the vanguard in the colossal work of reconstruction and of rehabilitation. Enormous problems will present themselves when our army disbands. Years will be consumed in demobilization. Restoration of our soldiers to the pursuits of peace in an equitable manner will be a nation-broad duty. The conduct of even so gigantic a war as this is comparatively simple to the colossal task of making the world over again when it shall have ended. But the re-education of the crippled, the maimed, the sightless and the salvaged after the war is a voyage across uncharted seas into another world. No longer will we attempt to salve the wounds of heroism with alms, or allow a mutilated patriot to eke out a pitiful existence as best he may; rather will it be our splendid aim to re-educate that unfortunate so as to give him a trade, or a profession more lucrative, more independent and ennobling than he had before.

For nearly a century and a half our nation has wrought into prominence those principles both of government and of right for which the philosophers have dreamed since the Rennaissance. Our federation of states is now the greatest, the wealthiest and the most powerful exemplar of democratic institutions in Christendom. It has been shown that the only way to make the world safe and secure is to entrust it to accredited representatives of the people and not to confide it to dynasties or diplomats, however great.

This is a war for the creation of a new international world; a war for a new intranational world. Human liberty, justice and the honorable conduct of an orderly and a humane society are the ideals of life which must prevail.

A combination of events has forced the United States into the position of leadership. We have demonstrated that race antagonisms tend to die away and disappear under the influence of liberal and enlightened political

institutions. Consider our large Babel-tongued population, all living in peace and harmony; as years pass they are melted in the crucible of democracy and are molded into Americans with all the strength and freshness of a nascent re-creation. Our democratic institutions have shown their ability to amalgamate and to emancipate every type of human being which has thus far come under our flag. It is the alchemy of the nations. Why should not each nation in Europe establish for itself a place in the sun of unity, which may come when the war clouds have been swept away? Who knows but coming out of this dread conflict in which the civilized world has been plunged will issue, as Nicholas Butler Murray has said, the United States of Europe!

In the end, each of the nations of the earth will deposit in a world's federation some portion of its sovereignty for the perpetuation of peace and the furtherance of good will to all.

It has been touching to see in this country the spirit of generosity, of sympathy for the afflicted, the distressed and the stricken in the uttermost parts of the world. Although denounced as get-rich-traders, the American people have been lavish with their millions and have given their lives and their endeavors to carry food, clothing and succor to the starving Belgians and the other desecrated nations of bleeding Europe. We have played the Good Samaritan on a huge scale. Never in all history has there been such a generous outpouring of tenderness to those who needed help, irrespective of race, station or belief.

In this beneficent work the representatives of the healing art have had their share. As for the Southern Surgical Association—to its lasting honor—your President wishes to record that out of two hundred members, fifty of whom are disqualified by age or obvious disability, seventy have given their services to their country. They are soldiers brave and fearless; yet they are gentle and harmless as doves. That great anatomist, physician, and author, Oliver Wendell Holmes, has beautifully said of our ministration:

As life's unending column pours,
Two marshaled hosts are seen;
Two armies on the trampled shores
And death flows black between.

One marches to the drum beat roll,
The wide mouthed clarions' bray,
And bears upon its crimson scroll—
Our glory is to slay.

The other marches in silence by the stream,
With sad, yet watchful eyes,
Calm as the patient planets' gleam
That walks the clouded skies.

Along its front no sabres shine,
No blood red pennons wave,
Its banner bears the single line,—
Our glory is to save.

THE TREATMENT OF CERTAIN FORMS OF SUBACUTE PANCREATITIS[1]

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I BELIEVE all surgeons are agreed that those cases of subacute pancreatitis in which there is abscess formation should be operated upon and drained, the abscess often being indicated by a palpable mass in the pancreatic region, sometimes filling the lesser peritoneal cavity and even bulging the abdominal wall; but I believe little attention has been directed to those cases of subacute pancreatitis in which the symptoms at the time of operation are not very acute, a diagnosis of gall-stones is made and at operation the pancreas is found to be thickened and indurated but still fairly well defined.

In these cases there is little or no free fluid in the abdominal cavity, and this not blood stained, attention being attracted to the pancreas only by the finding of disseminated fat necroses in the omental fat or in the peripancreatic tissues.

In previous papers I have emphasized the importance of early incision and drainage of

[1] Read before the Southern Surgical Association, St. Augustine, December 18, 1917.

the pancreas itself in cases of acute pancreatitis, and have reported four such cases, in three of which recovery followed drainage of the pancreas; in the remaining case which was a fulminant one, the pancreas was not drained and the patient died. However, I believe there would have been a fatal result in this case under any conditions. In the light of certain cases which I will presently report I believe that the same thing should be done on those cases of subacute pancreatitis which seem to verge almost on the chronic; in fact, I am inclined to believe that some of these represent an acute exacerbation of a chronic pancreatitis. I have operated upon three cases, which seem to belong in this category. In all of these cases a diagnosis of gall-stones was made, gall-stones were found in the gall-bladder, and a cholecystostomy was done, but the pancreas and peripancreatic tissues were not drained. In all of the cases, fat necroses were found in the omental fat or in the fat about the pancreas, and the pancreas itself was somewhat, in fact, in one case markedly, thickened and indurated, but the outline of the pancreas was fairly well defined. The condition, except for the fat necroses, suggested a chronic pancreatitis, therefore, the organ was not drained. One of these cases recovered and was in good condition when seen a year after the operation. The other two died, the one nine, the other sixteen days after the operation. Autopsies revealed extensive necroses of the head of the pancreas in both cases and in one there was extensive hæmorrhage in the tissues about the pancreas.

I believe that if pancreatic drainage had been instituted in these cases the result might have been different. The case reports follow:

CASE 1. Mrs. W. M., age 36, was admitted to the hospital April 14, 1911, complaining of pain in the abdomen, radiating to the back.

Family history, unimportant.

Personal history. The patient has had measles, mumps, and whooping cough. She had typhoid fever ten years ago. She has suffered with stomach trouble for eight years, manifested by vomiting and pain in the stomach, radiating to the back. She had nine children, the youngest being one month old.

Present illness. The patient gave birth to a child four weeks ago. Before the birth of the child she suffered from burning, cramp-like pains in the stomach, passing to the right shoulder, and these pains have become worse and continued to the present time. They have required frequent hypodermics of morphia. Six days ago she vomited a large amount of bile-stained material. At that time she was jaundiced. She had chills every night for a week after the birth of the child.

Examination. The patient is a thin woman and looks sick. The sclerotics are distinctly bile stained. The pulse is of fair quality, 92 to the minute. The temperature was 100° on admission. Leucocytes, 9,200. Coagulation time, four minutes. Urine analysis negative. The abdomen is flat and slightly asymmetrical, there being a fullness in the right hypochondrium. On palpation there is considerable tenderness in the epigastrium and right hypochondrium. No mass can be felt in the epigastrium, but in the right upper quadrant, the edge of the liver can be felt 5 centimeters below the costal margin and beneath this a rounded body, the size of a hen's egg, which feels like a distended gall-bladder. On inspiration it descends almost to the level of the umbilicus.

Operation. An incision was made through the upper portion of the right rectus muscle. The gall-bladder was found to be considerably distended, and numerous stones could be felt in it. The gall-bladder was aspirated and a large amount of bile obtained, which would seem to indicate an obstruction of the common duct rather than of the cystic duct. The gall-bladder was then opened and numerous small, faceted stones, and one stone the size of a walnut removed. A careful examination of the common duct failed to reveal any stones. The pancreas was examined and the whole organ found to be greatly enlarged and fairly fixed in position. In places the limits of the gland were not well defined. In the transverse mesocolon, near the pancreas, there were several areas of fat necroses, suggesting a subacute pancreatitis.

A large rubber tube was sutured in the gall-bladder and the abdominal wound partly closed.

Postoperative course. The patient did fairly well for a few days after the operation, then began to run a temperature and the pulse became more rapid. She died rather suddenly nine days after the operation.

Autopsy. About a liter of blood was found in the abdominal cavity. The mesentery of the ascending colon was infiltrated with blood. The head of the pancreas was converted into a necrotic, hæmorrhagic mass. Numerous fat necroses were found. The pancreatic ducts were patent but a firm calculus 5 millimeters in diameter was found in the ampulla of Vater.

CASE 2. Mrs. J. A. H., age 48, entered the hospital February 17, 1916, complaining of stomach trouble.

Family history, unimportant.

Personal history. The patient has never had typhoid fever. She had pneumonia 19 years ago, has suffered with "indigestion" for years, and has had four children, with no complications during labor or puerperium.

Present illness. About a year ago she had a severe attack of epigastric cramp, mainly upon the *left* side. The pain was intense and lasted about six hours. Since then she has had at irregular intervals similar attacks, sometimes with vomiting, sometimes without. There has been little if any temperature. Preponderance of pain has been in the left epigastrium, some, however, in the upper right abdomen with occasional radiation to the back. She has never vomited blood. Her last attack, which was very severe, occurred the day before admission and lasted about six hours.

Examination. The patient is moderately nourished, appears rather weak. The sclerotics are distinctly jaundiced. Temperature, 100°, pulse, 100, fair volume and tension. Urine examination shows a trace of albumin, no sugar. The abdomen is flat. There are no visible masses. There is tenderness across the whole upper abdomen, especially in the mid-epigastrium and a few inches to the left. No masses are felt. Liver dullness reaches to the costal margin in the right nipple line. A diagnosis of gall-stones was made.

Operation, April 20, 1916. A high right rectus incision was made. On opening the peritoneal cavity no free fluid was noted. The gall-bladder was found to be somewhat thickened and to contain gall-stones. Numerous fat necroses were found in the omentum and peritoneal fat. The pancreas was markedly thickened and firm throughout. No stones could be made out in the common duct. One large and several small, mulberry stones were removed from the gall-bladder and cholecystostomy done. The pancreas was not drained.

This seems to be an example of an acute exacerbation of a chronic pancreatitis.

Postoperative course. The patient had an uneventful convalescence. The wound healed nicely. The general condition was good at the time of discharge, four weeks after operation.

CASE 3. Mrs. J. H. H., age 48, was admitted to the hospital April 8, 1916, complaining of pain in the stomach.

Family history, unimportant.

Personal history. The patient has been having attacks similar to the present one for the last five or six years, coming on at intervals of several months and often lasting for several days, but none has been so severe as this one. There is no history of previous jaundice, chills, or fever. The bowels were somewhat constipated and the stools of yellow color. There were no urinary disturbances. She is the mother of eight children.

Present illness. About ten days before admission the patient was seized with severe cramp-like pain in the epigastrium, radiating to the back, more to the *left* and also down into the lower abdomen. She suffered much pain and vomited almost continually for a number of days. The pain has been almost constantly present since the onset. The patient has been very tender in the upper abdomen.

Examination. The patient is a rather stout woman. Her general condition seems fairly good. Her skin is slightly yellow and the sclerotics are definitely bile stained. Her temperature is 101°, pulse, 90, of good quality; leucocytes 15,000. Urinalysis negative. The abdomen is not distended. There is considerable tenderness in the gall-bladder region and as far down as the appendix region. There is some tenderness in the epigastrium and to the left. No masses are felt. The liver and gall-bladder are not felt. There is no dullness.

Operation, April 10, 1916. A high right rectus incision was made. No free fluid was found in the peritoneal cavity. The omentum was found adherent to the gall-bladder and showed numerous patches of fat necroses. The gall-bladder was moderately distended and contained one large stone without facets. There was considerable induration around the common duct, but no stones could be felt in it. The pancreas was much thickened and indurated throughout its extent. A rubber tube was sutured into the gall-bladder and iodoform gauze packed around the gall-bladder and toward the foramen of Winslow.

Postoperative course. The patient did fairly well for four or five days after operation. She then became more deeply jaundiced and began vomiting. The wound broke down throughout and discharged bile and a thin brownish fluid. Vomiting became persistent. Then pulse became rapid and weak. The temperature which had been elevated since admission gradually rose and during the last days ranged between 104° and 106.° She died 16 days after the operation.

Autopsy. A postmortem examination was made and revealed a subdiaphragmatic abscess, extensive fat necroses in the great omentum, mesentery, subperitoneal fat, and about the liver and right kidney. The pancreas was adherent and was dissected out with difficulty. Its head was entirely necrotic, leaving nothing but a blackish débris. Its body and tail were intact, but quite hard and showed nothing unusual on section. The pancreatic duct was necrotic and could not be found. No obstruction was found in the common duct.

SURGERY OF SOFT PARTS, BONES, AND JOINTS, AT A FRONT HOSPITAL

By Major E. H. POOL, M.R.C., Captain B. J. LEE, M.R.C., and Lieutenant P. A. DINEEN, M.R.C.
With American Expeditionary Forces in France.

THE Ambulance l'Ocean at La Panne, Belgium, under the management of Colonel Depage, is one of the best known hospitals in Europe. From it have emanated many of the epoch-making principles developed during the present war. But, besides having been pioneers in many of these important advances, the staff at La Panne is doing routine war surgery according to the most approved methods. It has been, therefore, a great privilege and of inestimable profit to us to pass more than two months doing active work in this institution.

Through the efforts of Major Lambert of the American Red Cross and the courtesy of Colonel Depage, we were sent to La Panne as a team by General Bradley, Surgeon in Chief of the American Expeditionary Forces. Our motive was to utilize the dull winter months in preparing ourselves as far as possible for the surgical work which we shall be called upon to do in the treatment of our men.

La Panne is a small summer resort on the coast of Flanders, East of Dunkerque and Calais and about six miles from Nieuport-Bains, which marks the Northern limit of the Western Front. It is composed of a former hotel with surrounding villas and a number of recently built wooden barracks. It can accommodate about 1000 patients. An auxiliary hospital is in course of construction at Vinckem, about nine miles south of La Panne, and about six miles west of Dixmude, the center of the Belgian lines. The hospital at Vinckem consists of frame buildings of the barrack type. It is planned for 1400 beds and can be readily expanded to a larger capacity.

In order to make clear the position of La Panne from a military point of view, we will outline the Belgian sanitary organization.

1. *A dressing station* for each battalion, with one medical officer and one student.

2. *Poste de secours divisionnaire*, a variable distance from the front line; to it patients are carried on stretchers. It is in charge of two medical officers. Few dressings are made; the patients are transferred as soon as possible to motor ambulances.

3. *Front hospitals*, of which there are three surgical; namely, La Panne, Beveren and Hoogstaede. Medical cases go to Cabourg.

4. *Base hospitals* at Calais and Bourbourg (France).

Doctor Depage is in favor of modifying this system. He believes that there should be three lines from front to base, each under the control of a front hospital. Thus, cases from a front hospital would be sent to one or more specific base hospitals and the control and direction of cases would remain in the same hands throughout the treatment. Under the present system, cases under treatment must be evacuated from the front hospitals, such as La Panne, during active bombardment or during busy periods when the hospital becomes full. Cases thus transferred are lost from a therapeutic and scientific point of view, and the transfer is furthermore a disadvantage to the patient. In general, however, cases are treated from first to last at La Panne, and it is primarily this fact which makes the service of such great value to the surgeon and the treatment so satisfactory to the patient.

At La Panne the wards are large barrack buildings of modern construction, each accommodating from 100 to 122 patients. The surgical work is divided into five services:

Head, spine, neck and face, Dr. Jansen and staff.

Thorax and abdomen, Dr. Debaisieux and staff.

Fractures, Dr. Vandevelde and staff.
Joints, hands and feet, Dr. Delrez and staff.
Soft parts, Dr. Limbrecht and staff.

This subdivision of the work is admirable both for the patient and the surgeon.

Accessory services are roentgenology, neurology, stomatology, opthalmology, nose and throat, and prostheses. A thoroughly equipped laboratory with efficient personnel is of great value to the clinician; moreover, it has made possible much valuable scientific work.

The *reception pavilion* is an isolated barrack building, sixty-five paces from the nearest surgical ward. It contains a reception ward of thirty beds, a night operating room, a roentgenological department and a barber shop. The last facilitates the early clipping and shaving of the entrants, a proceeding which is of importance in eliminating lice.

A patient on admission is given a bed bath; or in the case of ambulatory patients a tub bath. One fixed tub in the reception room suffices for this. The clothing, which is removed after the patient is placed on the bed, is put into a bag and sent at once to the disinfecting plant. We have seen no pediculosis among the ward patients, and there is no indication that even the reception ward itself harbors lice.

The patient is given 1500 units of tetanus antitoxin; his history is taken and chart begun. He is then examined by the Admitting Officer who is the roentgenologist. Most of the cases are taken at once to the X-ray department and from there to the appropriate ward. The system is simple, expeditious, and satisfactory. The roentgenologist is the director and is responsible for the co-operation of the assistants and the co-ordination of the work.

ROENTGENOLOGICAL DEPARTMENT

The roentgenological department is of necessity one of the most important features in such a hospital. Practically all cases must pass through it, and the results of the early operations depend largely upon the thoroughness of the roentgenologists' examination and the accuracy of his findings and report. The efficiency of such a department depends largely upon the ability and trustworthiness of the man doing the work. At La Panne a roentgenologist is always on duty.

A patient is taken to the X-ray room as soon as possible after admission, before or after being put to bed according to the indications of the case. The routine method employed in a new case depends upon the site of injury. Thus, in difficult cases, such as shoulder, hip, gluteal region, thigh, thorax, and abdomen, the bathymetre of Dessanes is used. For the cranium, plates are always made at once, because it is often difficult to recognize small foreign bodies. For simple cases, such as leg, forearm and arm, the Ledoux-Lebard bonnet is employed; the part is examined from different angles and the depth estimated. In most cases, an effort is made to cause the foreign body to move during fluoroscopy. For this purpose, pressure is made on the skin over the foreign body with the tip of a curved metal rod. Where the foreign body moves most freely, it is probably closest to the skin.

In an incredibly short time, Dr. Peremans localizes all éclats. He marks on the skin the point under which each one lies, making the mark as nearly as possible in the line of or in relation to the probable incision. This is usually quite accurately done because the roentgenologist in question has a good knowledge of war surgery and keeps in close touch with the surgical work of the institution. Such co-operation between the surgical and roentgenological departments is of great value, but it necessitates the employment of a broadly trained medical man as roentgenologist. It appears imperative in a hospital doing a large amount of work.

On the history chart, which has already been filled out, is made a note somewhat as follows: "right thigh, éclat 10x55 millimetres, 65 millimetres in depth, under the point marked on skin." Or in a case with fracture, "left leg, fracture of both bones, middle third, much comminution."

Plates of fractured bones are also made as a rule at the time of the first examination. If the operator wishes further information, Dr. Peremans is always available and goes to the

operating room where his advice is often of much value. With experience the operator acquires the knack of finding foreign bodies quite readily when they have been localized as above indicated. One should remember, however, to mark with a scalpel the points indicated on the skin before painting with iodine. For localization in later cases, especially in difficult regions, such as thorax, brain or pelvis, reliance is placed chiefly on the Hirtz compass. We saw astonishingly accurate localizations by this method. One of us removed an éclat about 1 centimeter in diameter from the psoas muscle within the pelvis through a trephine opening in the ileum. The foreign body had been localized exactly as to depth and closely as to direction by this method. We likewise saw a small éclat, which lay at the base of the brain in the middle fossa, removed through a trephine opening in the temporal region. In this case, the central rod of the Hirtz compass was introduced to the depth and in the direction established before the operation, the legs of the compass being on the respective points previously marked on the skin. A powerful electromagnet was then placed in contact with the rod which was withdrawn. Attached to it was the foreign body.

For the late removal of foreign bodies from regions in which the field of dissection is not of necessity limited, especially for very small foreign bodies, the method of Ombredanne-Ledoux-Lebard is often employed. For this purpose an operating room is attached to the X-ray Department. The room, which can be darkened by shades, is next to the night operating room, from which supplies are furnished. The table is the Ledoux-Lebard pattern with bulb beneath, and protected on three sides by lead aprons.

Plates are always made in examinations subsequent to the initial fluoroscopic observation. In the case of fractures, frequent observations are made.

A movable apparatus is available for use in the wards. For the localization of foreign bodies it is little used. Even bad cases are brought to the X-ray room, because localization is much better done on a fixed table. For fractures, however, the movable apparatus is imperative; proper treatment in a large proportion of cases demands frequent X-ray examinations without disturbing the patient.

Records of plates for filing with histories are made on tracing paper. The bones are filled in with a soft carbon pencil, and this is covered with varnish to prevent smearing.[1] Beautiful and quite accurate records are thus made.

The roentgenological department is managed by two doctors (Dr. Henrard and Dr. Peremans), assisted by two brancardiers, who develop the plates. There is no clerk or stenographer.

An estimate of the work demanded may be had from the following figures:

650 consecutive cases; 110 patients X-rayed with plates, average 3 plates; 350 fluoroscopic examinations.

The apparatus is the Grand Contact Tournant de Gaiffe, 220 volts, direct. Coolidge tubes rare used exclusively. The Bilot table is used in the main room, the Ledoux-Lebard table in the operating room.

We will summarize according to types of injuries the results of our observations of the practice at La Panne. As to the practical application elsewhere of the principles of treatment herein outlined, it must be recognized that La Panne is unique, in that it is a large permanent hospital near the lines, in which treatment is begun soon after the receipt of injury and continued until the patient is cured. This is in marked contrast to the conditions which prevail elsewhere, for instance in the United States Army, where the wounded must be treated serially in different units. However, most of the principles must be accepted as sound, and should be adopted in so far as local conditions permit.

The subjects will be considered in the following order: treatment of wounds of the soft parts, including bacteriological examination of wounds and primary and secondary suture (Pool); treatment of fractures (Pool); treatment of wounds of joints (Lee); treatment of wounds of hands and feet (Lee); Carrel-Dakin treatment (Dineen); anæsthesia (Dineen).

[1] Venice turpentine 6⅔ per cent in alcohol.

Since the object of this paper is to present accepted principles of routine surgery which are susceptible of practical application, regional surgery is not considered. The thorax, abdomen, cranium, spine, vessels, etc., present problems which cannot be treated adequately in an article of this type.

WOUNDS OF THE SOFT PARTS (POOL)

Wounds of the soft parts, which are the most numerous, may be taken as the basis or standard in the consideration of war surgery.

The aim in such wounds is to render them surgically clean and to close them as soon as possible. The wound is rendered "clean," primarily, by free excision of injured and contaminated tissues and the removal of foreign bodies.

The closure may be by (1) immediate or primary suture; (2) delayed primary suture, or (3) secondary suture.

The primary operation should be performed *within the shortest possible time* after the patient receives the wound. Let us visualize a trajet or tract from the skin to the interior of the muscle of the calf, containing a fragment of shell and pieces of clothing along its course, and having for its walls lacerated muscle. We must recognize the existence of pathogenic organisms throughout this tract. One can readily imagine, however, that immediate wide excision of such a tract as a whole, removing skin, subcutaneous tissues, aponeurosis and adjacent muscle, together with shell fragment, clothing and microorganisms contained within the tract, will leave an aseptic wound, provided, of course, the skin adjacent to the wound has been properly prepared and the operator has observed the same technique as in an ordinary clean operation. This in fact, is the ideal aimed at; practically, it is doubtful if in any given case it is actually achieved. But however skeptical one may be as to the total eradication of organisms under the conditions which prevail in these wounds, many of them after operation undergo repair as if aseptic and cultures and smears are often sterile.

The closure of the wound is made as soon as possible. If the excision is immediate and thorough, *primary suture* is done. If the operator is in doubt, the wound is left open and sutured subsequently, either after an interval of from one to six days[1] (delayed primary suture); or after a longer interval, roughly six to fourteen days (secondary suture). The determination as to the time usually depends upon bacteriological findings. Obviously the decision as to primary suture in a given case must be attended with much uncertainty; a mistake may be costly to the patient. Therefore, delayed primary suture is the safest and sanest procedure. But primary suture may be done safely in a large proportion of cases if good judgment is shown and the patient is carefully watched thereafter. However, it is generally to be condemned when the exigencies of a service demand haste or when a case must be transferred a long distance or must pass into unknown hands soon after the operation. Moreover, great caution must be shown in certain regions such as gluteal, thigh, and calf, in which severe infection is prone to occur and to result disastrously.

For convenience of discussion, wounds of the soft parts may be subdivided as follows:

I. Wounds by éclats or fragments of shells, grenades, or bombs: (1) éclat retained; (2) éclat not retained (chiefly *plaies en seton* — or through and through).

II. Wounds by rifle or machine gun bullets: (1) bullets retained; (2) bullets not retained (*plaie en seton*), (a) without and (b) with considerable hæmorrhage or laceration of muscle.

Some surgeons include shrapnel balls in the same category as rifle or machine gun bullets. This classification appears unwise on account of the lower velocity of the shrapnel ball and the fact that the German shrapnel balls are embedded in a pitchlike substance which can readily carry foreign material into the wound. Shrapnel balls, therefore, occupy a class between the éclat and the rifle bullet and, when the surgeon is in doubt, the wound should be treated as if made by an éclat. It is worth noting that shrapnel wounds are relatively infrequent in this sector.

[1] This period is variously and arbitrarily given from 1 to 3 to 1 to 6 days by various operators.

All of these wounds, with the exception of those by rifle bullets in which the projectile is not retained in the tissues, are treated in the same manner. We will outline this treatment.

General consideration of operative technique. One important feature, which cannot be too strongly emphasized, is that in the primary operation careful consideration should be given to the questions of ultimate closure of the wound and restoration of the function of the part. The treatment of wounds of the limbs will be described. These wounds are the most numerous and the most difficult to treat. The principles may be applied to wounds of other parts.

The skin incision should, when possible, be made parallel to the long axis of the limb, because such a wound is far more amenable to suture than is a transverse wound. A transverse incision should be made, in general, only when the possibility of successful primary suture is practically assured. In the case of a deep transverse wound *en seton* it is better to make two longitudinal incisions and to do a funnel-like excision inward from each, rather than make a transverse incision with excision of considerable muscle tissue. In the former case primary or early secondary suture is usually readily done, whereas in the latter, primary suture is often impossible, because of the difficulty of uniting the severed muscle; and even when this is accomplished the sutures frequently tear out and allow retraction of the muscle with resulting dead space and breaking down of the wound. When the transverse wound has not been closed, or has reopened, secondary suture is longer delayed and is much more difficult. Moreover, the functional result is less favorable on account of the transverse section of the muscle.

Next, if two longitudinal incisions are made they should be placed, as far as possible, on different transverse planes. Naturally when the wounds of entrance or exit are on the same horizontal plane, one has no choice; the central or widest portions of the two wounds must be placed directly opposite one another. Such multiple wounds, especially in the forearm, are often difficult to close by secondary suture at a single operation. This difficulty can be avoided to a large extent if the original operator has in mind, in a broad sense, the patient's interest and the ultimate outcome of the case. He should wisely plan his incisions, should avoid undue sacrifice of skin, and should record the amount of skin removed so that a later operator may properly estimate the potential elasticity of the skin.

The operation itself consists in the free excision of all tissues with which the foreign body has come in contact, except vital structures, the removal of which would interfere with the function of the part and cause permanent disability, e.g., nerves, large vessels and bones. *"Free excision," however, does not mean ruthless, blind butchery of the parts, but rather careful intelligent dissection with liberal removal of such parts as should be removed, and with equally scrupulous preservation of such parts as may be safely left.* The removal of tissue is begun by an incision of sufficient length; there is no advantage in attempting the dissection through a short incision. The incision surrounds the skin wound at sufficient distance to remove all contused skin. (When there are two wounds, one or two incisions may be employed as already described.) The subcutaneous tissues are removed as far as there is evidence of laceration or contamination. The opening in the aponeurosis is treated in the same manner as the skin. But the aponeurosis is of great value in secondary sutures of the lower extremity and shoulder and, therefore, should not be ruthlessly sacrificed. The muscle planes are now exposed and all traumatized muscle must be removed. This usually demands, in early cases, excision for about one centimeter on all sides of the tract. When the excision is complete all exposed muscle must look healthy and bleed and contract when cut, otherwise its vitality has been diminished to such a degree as to favor gas gangrene.

Two details must be emphasized: First, the tract should be kept in view and followed in the dissection from plane to plane. At times a grooved director may be introduced to facilitate this step. Second, in cases where the tract is lost or, for other reasons, difficulty arises in locating the foreign body, the Bergonié vibreur should be employed. This

failing, tissues should not be blindly torn up, but after free excision of tissues and a careful search for a reasonable time the operator should desist, should leave the wound open and locate the body by other methods, such as the Hirtz compass, and remove it subsequently.

When the éclat or tract is in proximity to a large vessel, for instance the brachial vein, the vessel should be inspected and if traumatized should usually be ligated and the contused portion excised; otherwise secondary hæmorrhage is likely to occur. But if the ligation would cause danger of gangrene it should not be done. Under such conditions primary suture should be made if possible, and the case carefully watched. Care should be taken to avoid injury to nerves by careless dissection. Severed nerves should be united and if possible buried in muscle. The dissection should be made by planes; muscles should be identified and dissected as much as possible in the direction of their fibers; the situation of nerves and large vessels should always be borne in mind.

The consideration of nerves and vessels naturally brings up the question of surgical preparation, and it cannot be too strongly emphasized that a thorough anatomical knowledge of the parts is imperative. Every military surgeon should make a conscientious effort toward such preparation.

The postoperative treatment of the wound at La Panne has been in general as follows:

1. Carrel tubes are introduced, but no vaseline gauze is applied to the skin. Carrel-Dakin solution is freely used. At the first dressing vaseline gauze is applied and the routine of the Carrel dressing is followed *daily*.

2. If hæmorrhage is present or is likely to occur the wound is lightly packed with dry gauze or gauze soaked in hæmostatic solution, and the Carrel treatment is begun at the first dressing. Under the Carrel treatment the wounds usually remain free from purulent discharge and slough, or if infected become clean quicker than by any other method which we have observed. There is one striking exception, namely amputation stumps, which often become covered with slough and are resistant to the Carrel treatment. In these wounds many tubes are necessary and must cover the whole surface of the wound. But Vincent's powder[1] applied generously to the dried stump for three days usually removes the slough.

Some operators do not use Carrel treatment at any time (Sinclair, etc.) but prefer dry gauze. Others employ gauze soaked in flavine and other solutions. Bismuth preparations, especially a combination of bismuth, iodoform, and paraffine known as "b. i. p." is employed in many front hosptials. Bismuth poisoning is not unusual; the good results attributed to the use of bismuth preparation may be explained in other ways.

Gas gangrene as a postoperative complication is not of frequent occurrence, yet it occasionally develops. However, it can usually be satisfactorily combated, even after primary suture, if it is recognized in its early stage as it should be. We saw a case of gas gangrene after delayed primary suture of a wound of the thigh which was sutured 24 hours after the initial operation of excision of tissues. High fever, delirium and dyspnœa rapidly developed. Although severe bronchitis was definitely established, Dr. Vandevelde suspected wound infection. Examination 24 hours after the operation revealed marked swelling and tympany on percussion over the anterior aspect of the thigh. The wound was opened; the typical smell was at once noted; considerable sanguinous fluid and gas were evacuated. Since the muscles appeared to be healthy they were not excised. Carrel treatment was instituted. Cultures and smears showed bacillus aerogenes capsulatus in small numbers. Immediate improvement resulted. In most cases, however, free excision of the devitalized muscles should be made as soon as the presence of gas gangrene is established.

Septicæmia is treated with much success by injections of peptone, as suggested by Nolf, of Liege. We saw two cases of staphylococcus and one of streptococcus septicæmia recover after this treatment. In each three blood cultures were positive. The streptococcus case was given 13 injections. The

[1] Acid boric 90 grams, chloride of lime 10 grams. Mix and strain very fine.

routine procedure is to inject intravenously 10 cubic centimeters of 10 per cent commercial peptone every two days.

Dissolve peptone in physiological salt solution, distilled water or Ringer's solution, in quantity to make 10 per cent solution. Sterilize 20 minutes or more at 120° C. It is allowed to stand 5 to 8 days, then filtered or decanted into test tubes, each containing 10 cubic centimeters. Test tubes are sterilized 20 minutes or more at 120° C. The solution must be clear. It remains good for 3 to 4 weeks if kept in an ice-box.

Wounds by rifle or machine gun bullets. Wounds *en seton* by rifle bullets, projectile not retained, are not as a rule operated upon. Infection usually does not result, owing to the fact that the projectile rarely carries foreign material into the wound, and moreover, penetrates with little laceration and traumatization of the tissues, especially the muscles. However, under certain conditions wounds *en seton* by rifle bullets must be treated in the same manner as those made by fragments of shell, that is, when the appearance and feel of the part suggests considerable hæmorrhage or destruction of muscle and when the wounds of entrance and exit are relatively large and lacerated rather than punctate. At close range a rifle ball exerts an explosive force or effect; at long range it loses the "end-on" spinning course and wabbles like a dying top and thus causes mutilation and laceration.[1]

Wounds of the face. Wounds of the face must be considered independently. However severe, extensive and dirty the wound, virulent pyogenic infection and gas gangrene are not prone to develop. This feature makes it possible by timely operative intervention to avoid in most cases the gruesome mutilation which in the early days of the war was so often allowed to occur. The safe rule is to *repair the wounds of the face as soon as possible after the receipt of the injury without general excision of tissue.* The wound is cleaned thoroughly and only such tissue is removed as is definitely devitalized. Such wounds unit quite regularly. Secondary plastic operations are made to improve unsightly scars, reconstruct angle of the mouth, etc. The frequently associated fractures of the maxillæ should be splinted by a surgeon dentist. The wire splint attached to the teeth, as used by Dr. Rupprecht of La Panne, is relatively simple and comfortable; the results are good.

Bacteriologic examination of wounds indications for delayed primary suture. (a) After the primary operation of *débridement* and excision of tissues, the wound is lightly packed with moist or dry gauze or the Carrel treatment is begun. Twelve to twenty-four hours later the wound is dressed and a culture and a smear are made. A report based upon the smear alone or the smear and culture is returned as soon as possible. If no organisms are found, suture is made. If anaerobic micro-organisms or streptococci are present, suture is not considered. A very few staphylococci do not contra-indicate suture. We have seen the practical importance of this bacterial differentiation; namely, bad results from suture over streptococci, and satisfactory results from suture over a few staphylococci.

b. In some cases delayed primary suture is made after 18 to 48 hours, without bacteriologic examination, on clinical data alone, that is, the thoroughness of the original operation, condition of patient and aspect of the wound. A culture and smear are made at the time of the suture. The subsequent treatment of the wound depends upon the clinical course and the bacteriologic findings.

Indications for secondary suture. The routine generally observed is as follows: After 48 hours, at the daily dressing a culture and a smear are made. These are examined in the laboratory. The first report, therefore, contains the approximate number of organisms per field and the varieties of organisms. Thereafter, a smear is made every two days.

[1] My own usual practice is now as follows: At the close of the original operation the wound is cleansed with warm saline solution followed by ether. If delayed primary suture seems probable, vaseline gauze is laid along the edges of the wound overlapping the raw surfaces about one-quarter to one-half inch; in the center, gauze moistened with Dakin solution is loosely laid. A Carrel tube is placed on this so that the gauze may be kept sufficiently moist to prevent it adhering to the wound. Over the whole dry gauze is placed. This method minimizes pain and hæmorrhage at the dressing. Moreover, the dressing is simplified, which is important especially in compound fractures which should be immobilized from the first. The first dressing is made in about 18 hours and smear and culture are taken from all parts of the wound. If the culture shows absence of streptococci and there are present only few other organisms, the wound is sutured as soon as possible.

If the wound is not closed early, prolonged exposure will ultimately result in infection. Therefore, Carrel-Dakin treatment is inaugurated as soon as it is evident that delayed primary suture is not advisable; to prevent infection, growth of organisms and reaction of the tissues to the organisms; or to combat existing infection.

Care must be taken not to touch the skin surface in making the smear since this vitiates the value of the report. From the smear a bacterial curve is plotted according to Carrel's plan. When the organisms on two successive counts are as low as an average of one per two fields the wound is considered susceptible of secondary suture, except when the wound has contained streptococci. In that case careful cultures are made from granulation tissue and the discharge from all parts of the wound.[1] Suture is not made if any streptococci are found. It has been observed that they are prone to lie dormant in small numbers but to flare up and to cause virulent infection after suture of the wound.

Primary suture. Primary suture or immediate suture of wounds with or without complicating fracture is now made in a large proportion of cases. There is a constant tendency to employ it on an increasingly large scale. The advantages are obvious; the disadvantage consists chiefly in the danger of closing within the wound noxious microorganisms, especially bacillus welchi or other anaerobes and streptococci. The resulting gas gangrene or virulent pyogenic infection in a few cases will counterbalance many successful closures. The only means of rendering primary suture reasonably safe is by extreme operative care and thoroughness; thoughtfulness and judgment in the selection of cases for suture, and finally scrupulous watchfulness for some hours, and even days, after the operation.

Under conditions, such as a rush, which demand haste in the primary operation, or when the patient must be transferred a considerable distance or lost from control soon after the operation, primary suture should not be made. We were told at a base hospital that in one week four amputations had been made in cases of primary suture that had been done at hospitals near the front.

In all doubtful cases, *delayed primary suture* should be elected. It is done in from one to three days and may be rendered safe by a bacterial check. The disadvantages are the possibility of postoperative contamination of the open wound and the subjection of the patient to a second operation, with the attendant discomfort, danger of pneumonia, etc. However, these disadvantages do not equalize the risk incurred by primary suture in doubtful cases.

Technique of primary suture, including delayed primary suture, iodine preparation. The muscles and aponeurosis are approximated with interrupted catgut; the skin and subcutaneous tissues with silkworm. It must be emphasized that in all primary and secondary sutures, hæmostasis should be as complete as possible and dead spaces should be avoided. After primary suture in muscular parts a pressure dressing should not be employed. A tight dressing may interfere with the circulation. A muscle with deficient blood supply is favorable for the development of gas gangrene.

Technique of secondary suture. The skin is cleansed with ether and painted with 3½ per cent tincture of iodine. The incision surrounds the new epidermis along the wound edges; a healthy normal skin edge must be present for a successful suture. The skin is freed in all directions as far as is necessary in order to approximate the edges with the minimum tension. Dense scar tissue or projections of granulation tissue are removed from the wound. The deep fascia is then approximated with interrupted catgut when possible. Usually this may be done in thigh and shoulder; but rarely in the leg, arm, and forearm. The skin and subcutaneous tissues are closed with silkworm. Considerable tension may be allowed, far more than we are in the habit of permitting in civil practice. If little skin was removed at the original operation, the skin stretches in a short time, tension is relieved, and good union results. However, in my observation, the result of suture is directly proportionate to the degree of tension. If there is extreme tension, infection may be expected. It is surprising, however, how well most of these wounds do even after some infection. I have seen no cases which required complete reopening of the wound, exclusive of amputation stumps. Even in the worst cases, the operation was of

[1] In view of the importance of recognizing the presence of streptococci a culture should be made before suture, even if streptococci had not been identified in the original culture. This has recently been adopted as our practice. Blood agar plates are used.

advantage. When two longitudinal wounds are on the same transverse plane in a limb, with considerable loss of tissue in each, one wound can usually be closed completely and the other closed in part. A dry dressing is applied and the wounds are left for about eight days when the sutures are removed. The unclosed portion then presents a flat, clean, granulating surface.

The practice has been adopted at La Panne of giving tetanus antitoxin (1500 units) at all secondary operations which are made more than seven days after admission, that is, after the administration of the initial dose.

FRACTURES (POOL)

Fractures may be subdivided for purposes of discussion into (1) compound fractures caused by projectiles; (2) compound fractures caused by accidents; and (3) simple fractures.

Compound fractures caused by projectiles. In all compound fractures caused by projectiles, the wounds of the soft parts must be subjected to exactly the same primary treatment as wounds uncomplicated by fracture. The bone complication simply accentuates the importance of expedition, thoroughness, and early closure. The last is especially important here because it means the conversion of an open into a closed or simple fracture.

The operative treatment of the fracture itself varies. When the bone has been broken by direct impact of the projectile, in other words, if the trajet passes to the bone, the fracture should be freely exposed, very small fragments and displaced fragments which are detached from periosteum should be removed, but the temptation to remove fragments freely should be resisted. The bone is macroscopically cleaned as well as possible without entering the medulla or removing periosteum. As a matter of fact, however, little can be done in the direction of cleansing the bone, and certainly nothing that is in any way comparable to the cleansing of soft parts by excision of tissues. Free irrigation with saline solution is advantageous in order to remove minute foreign particles, though some operators advise against irrigation.

A bone which has been fractured by the shock of a projectile, but presumably without actual contact with the projectile is not in general unduly exposed in the dissection and does not demand any efforts at mechanical cleansing. Here, too, fragments should be conserved as far as possible.

In both of the above classes the subsequent treatment of the wound comes under the same general rules as apply to wounds of the soft parts alone; primary, delayed primary, or secondary suture may be made and the Carrel-Dakin solution may be employed as in wounds without fracture. In the consideration of the closure of such wounds it must be recognized that the fracture in the event of infection exposes to the danger of osteomyelitis with the consequent increased danger to life, limb, and function. The development of osteomyelitis, particularly osteomyelitis of a serious grade, is favored by a closed infected wound, especially if the case is not carefully watched and the wound is not immediately reopened. Therefore, the advantage of delayed primary suture over immediate suture, and the disadvantages of closure when the operation must be done hurriedly or the case must be transferred very soon into other hands, are even more striking in the case of compound fractures than in wound of the soft parts without fracture. Whether the wound is sutured or left open, it is as a rule inadvisable to employ foreign materials such as wires or plates to hold the ends in position. Foreign bodies favor the development of a severe grade of infection and osteomyelitis. However, I have seen them employed with satisfactory results in cases both of primary and secondary suture and have seen no untoward developments from their use. Yet, it must be emphasized that such cases have constituted a small minority and were carefully selected by experienced surgeons. The most frequent employment of a foreign body has been an encircling wire to aid in reduction and immobilization when the wound is not sutured. But in the presence of probable infection the ends of the fragments should not be fixed by the wire in such close approximation as to seal the medullary canal. Wounds that are left open are treated in the same manner as those of the soft parts alone.

In addition to the treatment of the wound, in all of these cases, provision must also be made for reduction and immobilization of the fracture. This is accomplished in numerous ways and frequently demands the exercise of considerable ingenuity.

Apparatus for compound fractures. We will consider the treatment of fractures only at hospitals where the cases are retained for a considerable time. This review is based upon our experiences at La Panne and observation of the work of Sinclair, Schlesinger and others at British Base Hospitals at Calais and Boulogne.

The diversity of opinion as to the merits of various splints and methods is astonishing, but whatever method is employed careful observation and continuous care of the individual case is essential and without these no method will give uniformly satisfactory and trustworthy results. The long accepted rules of treatment must be followed, namely reduction, immobilization, accessibility to the wound and comfort.

Perfect reduction should be aimed at and attained as soon as possible. For this the employment of a mobile X-ray apparatus is imperative, and repeated observations should be made when necessary. In most cases traction must be used to secure reduction and prevent recurrence of the displacements. Sinclair even aims at producing an elongation of the fractured limb. He finds that proper traction will replace most of the displaced fragments. Further, he believes that it will correct abnormal positions of nerves, veins, and lymphatics, and thus favor tissue repair.

The importance of immobilization cannot be too strongly emphasized. The fractured part should not be moved in such a way as to cause a change in position of the fragments. Therefore, in general, compound fractures will do better if dressed without change in the traction and immobilizing apparatus.

A detailed description of apparatus is unnecessary. An admirable practical summary is available in the *Manual of Splints and Apparatus for the Medical Department of the United States Army, 1917.* The application of the much used Balkan-Blake method of suspension and traction is accessible in *Le Presse Médical*, November 19, 1917. Numerous other articles dealing exhaustively with apparatus for fractures have recently been published. We will, therefore, confine ourselves to a brief consideration of a limited number of splints and apparatus which may be employed for the treatment of compound fractures in base hospitals.

For fractures involving the *upper arm and shoulder*, the straight metal rod support recommended by Sinclair offers advantages, especially where traction cannot be applied to the arm for the employment of the Blake apparatus and where the situation of the wound precludes the use of a Thomas splint. The rod is supported by a rope from each end leading to an overhead pulley and weight. The limb in abducted position with elbow extended is suspended beneath the rod by flannel or canvas slings. Traction is exerted in the long axis of the limb by means of bands glued to the forearm. From these a rope passes to the pulley and weight. This method gives traction in proper direction, fair immobilization, accessibility for dressings, and relative comfort.

For *arm and forearm* the Blake suspension method in general best meets the indications.

For *wrist, hand, and fingers*, attention should be called to the Sinclair cock-up splint. It should be used more generally in late treatment or when the Carrel-Dakin solution is not employed, also in certain simple fractures. It is an ingenious device with which almost anything can be done.

For the *upper third of the femur*, which is one of the most difficult fractures to treat, no thoroughly satisfactory method appears to have been devised. The net support and frame of Sinclair is favorable as to comfort, accessibility of wound and results, but it requires much space, is rather expensive and troublesome in respect to nursing. Vandevelde recommends and employs the long Thomas with modified Finochietto stirrup, provided the ring of the splint does not interfere with the wound. In such an event, the Thomas is omitted and the stirrup is used, with or without suspension of the limb in such a splint as the Hodgen; the other limb is

abducted to the same degree and held in that position with traction by rope, pulley, and weight.[1]

For the remainder of *femur and leg*, traction by weight and pulley with overhead counterweight suspension is in general satisfactory. But for fractures of the femur the natural anterior curve of this bone should be studiously preserved as emphasized by Sinclair. *Lower third fractures* often demand traction applied through the condyles of the femur.

In *fractures of the leg* a useful modification may be employed which adds greatly to the comfort of the patient. A short Thomas splint is used reaching to the middle of the thigh where it is fixed by means of flannel bands attached to the skin by Sinclair's glue. The bands pass from below upward, and are attached to the ring of the splint. This method was apparently first suggested by Laurie of the Third British Army.

We have modified the Thomas in such a way as to allow a cut out of the splint over a wound so as to provide accessibility in dressings. Moreover, the splint is so planned as to have a support for the limb in transportation. This splint has been found useful in fractures of the leg. The same principle might also be of advantage for fractures of the femur. The Hennequin splint has likewise proved satisfactory and comfortable for fractures of the leg.

The Sinclair foot attachment to apply traction is admirable and is undoubtedly destined to replace to a large extent stirrups and bands attached to the leg.

Compound fractures caused by accidents. These are operated upon as routine at La Panne and when it is possible the following procedure is followed: The edges of the wound are excised, contaminated or lacerated tissues are carefully excised, the fracture is exposed and as far as possible the fragments are reduced. Foreign bodies such as plates, screws and wires are not employed except in rare cases for the reason already given under "Treatment of Compound Fractures caused by Projectiles." The wound is closed by layers without drainage.

Simple fractures. These are treated as in civil practice. For fractures of the humerus we have seen at La Panne Leclercq's apparatus used with much success. For the femur and leg Delbet's walking plaster (*appareil a marche*) is employed to a considerable extent with good results.[2]

Amputations. Amputations should not be done unless the part is positively beyond saving as a useful limb either as a result of the original wound or later infection. The guillotine amputation is often advantageous; cutting as low as possible on the limb. It is rapid and conservative. However, skin flaps should be made where this is possible. The wound is treated with Carrel using many tubes which for convenience may be united together in a variety of ways before sterilization. One method is to fix a number of tubes about half an inch from one another by passing them through a series of holes in another tube; another method is to sew the tubes to a large square of gauze. The tubes are so arranged that an area of the gauze exactly corresponding to the wound surface is thickly covered with the perforated portions of the tubes. If the wound presents considerable slough, as is frequently the case, Vincent's powder may be used to advantage. The wound and skin are cleaned as in the Carrel dressing, the wound surface is dried, the powder dusted on freely and a dry dressing applied. The case is followed bacteriologically just as wounds of soft parts and is sutured secondarily according to the same rules.

A convenient modification is to saw the bone somewhat distal to the section of the soft parts; its end is drilled and a copper wire passed through. The wire is left as a double strand about 8 inches long. It may be used conveniently to support the stump during dressings or while the patient is in bed. A rope from the wire leads to overhead pulleys and thence to a small bag which the patient can readily reach. The weight is so balanced as to support the stump. The patient may

[1] A very satisfactory apparatus for fractures of the upper third is as follows: Both limbs in abduction are suspended in Hodgen splints. Traction through flannel strips glued to leg and leading to weight. Foot of bed elevated to neutralize tendency to pull patient downward. Feet kept at right angles by strips glued to soles, thence to rope pulley and overhead weight. Half mattress reaching to buttocks.

[2] Appropriate exercises as described in, "Systematic Exercises in Postoperative Treatment," Eugene H. Pool, M.D., J. Am. M. Ass., 1913, lx, 1202, are advisable and should be practiced when possible.

COMPOUND FRACTURES BY PROJECTILES

	Total Successful	Total Partially Successful	Total Unsuccessful	Gravity of Infection
Primary Sutures—				
Successful				
Forearm....5				
Arm....3				
Leg....5				
Pelvis....1				
Scapula....1				
Femur....3				
Total.... —	18			
Unsuccessful—Nature of infection				
Gas bacillus....1				
Unidentified....1				
Total.... —			2	
Gravity of Infection				
Cellulitis....1				
Gas gangrene....1				
Total.... —				2
Delayed Primary Sutures 1 to 6 days				
Successful				
Radius....1				
Forearm....1				
Arm....5				
Legs....3				
Femur....				
Total.... —	10			
Partially Successful				
Scapula....1				
Arm....1				
Pelvis....1				
Total.... —		3		
Secondary Sutures				
Successful				
Radius.... 4				
Forearm....28				
Arm....34				
Clavicle.... 1				
Scapula.... 2				
Tibia.... 1				
Leg....22				
Femur....20				
Total.... —	112			
Partially Successful				
Arm....1				
Forearm....1				
Pelvis....1				
Femur....5				
Total.... —		8		
Unsuccessful—Nature of infection				
Leg....4				
Streptococcus forearm...2				
Straphylococcus....0				
Gas bacillus....1				
Other infection (Tetanus) 1				
Streptococcus....2				
Total.... —			9	
Gravity of Infection				
Cellulitis....4				
Gas gangrene....1				
Cellulitis....2				
Total.... —				7
Grand Total....	140	11	11	9

remove sand bag and lower stump upon pillow or apply weight and lift stump, thus suspending it in the air. In cases of lower limb amputation temporary prostheses are applied very early and the patient is encouraged to walk.

Prostheses for the lower extremities, especially for thigh amputations have been developed to a surpassing degree at La Panne by Dr. F. Martin. The artificial limb is accurately modeled after the normal limb.

I cannot leave the subject of fractures without paying tribute to Dr. Vandevelde, a young Belgian surgeon, who has charge of the fracture service since the foundation of the hospital. His work is superlatively good, his personality delightful, and his courtesy and generosity to us have been incredible.

Dr. Vandevelde has kindly allowed us to present certain statistics of his service for the past eighteen months: first, the results of suture in compound fractures; second, the results of suture in amputations and disarticulations of joints.

The figures on fractures should not be taken as an index of the percentage now sutured, because during the early months of this period fewer cases were sutured than at present, and primary and delayed primary suture were rarely done.

AMPUTATIONS AND JOINT DISARTICULATIONS

	Successful	
Primary Sutures—		
Leg....	1	
Forearm....	1	
Total....	—	2
Delayed primary sutures 1 to 6 days....	0	0
Secondary Sutures—		
Disarticulation of shoulder....	1	
Disarticulation of elbow....	1	
Arm amputation....	10	
Forearm....	1	
Thigh....	5	
Leg....	4	
Total....	—	22
Grand Total....		24

THE SURGERY OF JOINTS (LEE)

The treatment of joint wounds, as carried out at La Panne, can be divided into four separate periods, in the following manner:

First period, to September 1915: Excision of tissues; drainage; antiseptic irrigations (H_2O_2, formol or carbolic acid); immobilization.

Second period, to July 1916: Excision; Carrel-Dakin treatment in the joint; immobilization.

Third period, to July 1917: Excision; lavage of the joint with Carrel or ether; immediate joint suture, allowing, however, for drainage of the joint for 24 hours; immobilization; passive movement and massage in 8 to 10 days. The results obtained with wounds of the knee in the first two periods mentioned and a part of the third are briefly

given by Depage, in *Bulletins et mémoires de la Société de Chirurgie de Paris*, in December, 1916.

Fourth period, July, 1917, to the present: Excision; irrigation with saline and ether; immediate complete joint suture; immediate active mobilization. This method was introduced by Willems some time before it was begun at La Panne by Dr. Delrez where it has been continued by routine ever since. Recent case reports by Willems may be found in the journal mentioned above, for October 9 and November 13, 1917.

The treatment herein outlined is that followed at La Panne in the service under the control of Dr. Delrez.

The surgery of joints may conveniently be considered in the following classification:

I. Wounds by éclats or fragments of shells, grenades or bombs: (a) without injury of bone or with little injury of soft parts or bone; (b) with much injury of soft parts or bone.

II. Wounds by rifle bullets. (a) with little injury of soft parts or bone, (b) with much injury of soft parts or bone.

As indicated under the section on soft parts, wounds by shrapnel balls occupy a position between wounds by éclats and those by rifle bullets.

III. Wounds by sharp instruments.

IV. Acute purulent arthritis.

Wounds by éclats or fragments of shells, grenades or bombs. The treatment of wounds of the soft parts having been completely considered, it is unnecessary to describe in detail the operative procedure for wounds of joints. At the outset, however, certain important principles should be emphasized:

First, here, if anywhere, in the field of war surgery, good surgical technique is absolutely essential.

Second, careful radioscopic and radiographic examination must always be made, for the recognition of bone injury and foreign body localization may be of vital importance.

Third, during the operation, every practical means of localization must be made use of in order that the position of the foreign body within or without the joint may be accurately established. The retained body may then be removed with the least possible injury to the joint.

Fourth, soft tissue dissection should here be carried out in the most painstaking manner, in order that a joint, not entered by the projectile, may be spared an operative entry by the surgeon.

Fifth, the joint must not be opened without satisfactory demonstration of the wound of entry, which may be exceedingly small and, therefore, difficult to find. Under these circumstances, if a foreign body is retained, an incision is made over the foreign body itself, whether it be within or without the joint. To miss a small wound of entry is, on the other hand, just as serious a matter, for acute joint infection may follow. We have seen the development of a severe purulent arthritis of the knee result from such an error.

Sixth, complete excision of all soiled lacerated tissue and removal of all foreign bodies and materials is essential.

Seventh, irrigation of the joint with saline solution followed by flushing with ether is the usual procedure.

Eighth, *complete primary suture* of the joint is a vitally important principle in joint surgery.

Ninth, *early active joint movement* is of prime importance. Moreover, immediate movement is considered absolutely necessary if the surgeon believes that a considerable amount of blood has been retained within the joint; in that event, if the joint is immobilized, it is believed that fibrin will soon deposit within the articulation and be followed by a benign arthritis. This condition adds to the difficulty of restoring normal joint movement, an opinion, however, which is based upon clinical experience only. Upon the other hand, immediate mobilization should be deferred for 5 or 6 days, if there has been considerable loss of muscle tissue overlying an extensive body lesion. A compressive dressing to obliterate dead space and a joint rest are here essentials.

In wounds without injury of bone or with little injury of soft parts or bone the incision of approach to the joint must be determined by the situation of the skin wound of entrance and of exit or by the site of the foreign body itself. There is, therefore, no rule for a

routine incision. For the knee, however, the lateral incisions are the more desirable, made as nearly as possible in a vertical direction. The wound of entry into the joint and if one exists, the wound of exit, should be carefully excised, and enlarged as much as is necessary. The superficial soft tissue wound and the opening into the joint must be sufficiently ample properly to expose the trajet through the joint. An éclat, retained within the joint, and all other foreign material must be removed, as well as all soiled soft tissues. Loose or semi-detached bone fragments should be excised and all soiled bony surfaces or articular cartilages rendered clean by the use of a curette, rongeur, or gouge. Any subsequent procedure to reach and remove an éclat retained without the joint is outlined under the section on soft parts. If the éclat be small and embedded in the knee close to the attachment of the synovial membrane, it is sometimes possible to remove the foreign body without entering the joint. This is accomplished by pushing back the synovial membrane until the éclat is definitely extra-articular. For certain cases, a minute drain may be led down to the bone at the former site of the éclat; usually, however, this is omitted. Thorough irrigation of the joint with sal'ne solution is then practised followed by flushing with ether. The surgeon should refrain from active rubbing or sponging of the synovial membrane as such a procedure is definitely traumatizing.

Immediate complete closure of the joint is then carried out. The synovial membrane is closed with an extra-articular suture of fine catgut and the capsule with interrupted catgut stitches. The overlying muscles are approximated with catgut and the skin sutured with interrupted silkworm-gut. If there has been considerable oozing, a small drain of rubber tubing or rubber dam should be placed in the superficial soft tissues but never into the joint, and removed within 12 to 24 hours. Closure without drainage is the absolute rule under every other circumstance, for a drain increases the liability to infection.

Active mobilization of the joint is begun the following day and continued three or four times daily and at least once during the night for the next few days. With lower extremity cases, walking is begun, if possible the day after operation and continued with increasing frequency day by day. Crutch support is allowed the first day, then a cane is substituted, and shortly this is also discarded. The upper extremity cases likewise begin early with light work about the ward with a brush, broom or duster, gradually increasing the joint movements. By the third or fourth postoperative day, the active motions are made very frequently, practically as often as the patient can be induced to do them. During the night the man is wakened two or three times and active movements insisted upon. Passive motion should never be used, as traumatism may be done to the joint. The patient complains a good deal for the first two or three days of active movement, but after that period he is reasonably comfortable.

In case of much injury of soft parts or bone, the exposure may have to be a good deal more ample, but the same general routine is followed. The operator must be parsimonious in his conservation of skin and soft parts as well as of capsule and synovial membrane, for complete primary suture is the object sought. If the capsule is destroyed at its attachment to the upper end of the tibia or the lateral aspect of the condyle, it is very difficult to make a satisfactory closure of the joint over this area. A defect anywhere in the joint capsule should be closed if possible by utilizing adjacent muscle or fascia. Even in the presence of considerable loss of bone, if a fair articulating surface remains, immediate suture is desirable. In dealing with the shoulder, elbow, and wrist, the routine outlined for inconsiderable injuries is definitely indicated. With wounds of the knee with extensive bony injury, the period of rest and immobilization should be prolonged for several days and active movements should not be begun for a week or 10 days. The remaining management of the case should be definitely more conservative. In wounds of the ankle-joint with much bony injury, the procedure of choice is an astragalectomy, with immediate suture, wherever possible.

Partial primary suture should be attempted if complete closure of the joint, soft parts, and skin is impossible. An effort is made to close completely the synovial membrane and capsule and to approximate muscles and skin over the joint suture line. The angles of the wound are thus left more or less widely open and are packed loosely with dry sterile gauze and a gauze dressing applied. The following day the packing is removed and Vincent powder is shaken into the open wounds. Dry gauze is loosely placed in the wounds and a sterile dressing used. Such a dressing is renewed daily. Carrel-Dakin solution, with tube introduction is considered at La Panne less desirable in this situation, than the wound treatment as described. It has seemed less effective than the powder in combating infection, especially of the streptococcic variety. The postoperative course is necessarily tedious, but the attempt at active motion and normal use of the joint is steadily persisted in. The ultimate outcome in joints partially closed may be one of the following:

1. Primary joint healing, and a gradual closure of the wounds of the soft parts, with or without a mobile joint. If no motion is preserved, it is important that the ankylosed position should be the most useful one for the particular joint involved.

2. Primary joint healing and later a suture of the soft parts is accomplished. This, however, is seldom possible. The joint may be mobile or immobile.

3. Delayed primary suture of a joint is practically impossible to accomplish, and secondary suture of a joint is exceedingly rare. At La Panne, Dr. Delrez has, however, twice successfully made a secondary joint closure in the past six months, in both instances the joint involved being the knee. One of the cases was closed ten days after the primary operation, the joint having remained practically clean throughout that period. The second case was closed after the development of a mild purulent arthritis, which subsequently subsided.

4. *Resection.* This is indicated where the damage of soft parts or bone is so extensive that a reconstructed capsule or a satisfactorily functionating joint seems impossible. It may also be made use of where partial primary suture has failed to furnish a movable joint or has resulted in serious infection. Resection having been performed under the first conditions mentioned, sufficient shortening of the limb may have been accomplished to permit the reconstruction of a complete new capsule and a closure of soft parts and skin. One case of elbow resection has been encountered in which it was impossible to make a complete skin closure at the time of resection, but in which a secondary suture was successfully done several weeks later.

The management already outlined for joints is followed in the cases of resection, but at least two weeks should elapse before the institution of active mobilization. Later some type of apparatus may be used to confine the joint movements within the normal range.

The operation is not infrequently carried out at La Panne for elbow cases, whenever the injury to the articular surfaces is so complete that a reconstruction of the joint is impossible. With the knee, however, resection is very rarely done. The tendency seems more and more definite to resort to amputation than resection, if complete or partial primary suture of the joint cannot be done. An earnest attempt is always made to accomplish at least a partial primary suture, even at times in cases where many surgeons would decide for resection. Where partial primary suture cannot be accomplished, resort is usually had to amputation.

5. *Amputation.* This is indicated when complete closure with an immediate resection is impossible or where functional disability or serious complicating infection exists. Moreover, if either circulatory or nerve damage is irreparable, or the injury to soft parts and bone very extensive, amputation is done by disarticulating, saving at the same time as much skin as possible for immediate or late closure of the stump. Loose sutures may be placed, and dry gauze dressing applied. If part or all of the stump is uncovered, Vincent powder with dry gauze is considered the best dressing. Later, secondary suture may be made use of. In some instances, an amputation above the joint must be performed be-

cause of soft tissue damage in and about the joint. This operation is often necessarily rapid for the patient's condition may be desperate.

II. *Wounds by rifle bullets* (a) *with little injury of soft parts and bone.* With a through-and-through wound, abstain from operative interference, whether or not a fracture within the articulation complicates the joint wound. The bullet is not considered infectious and surgical intervention will add an element of possible infection and one more traumatizing factor. Thorough cleansing of the wounds and surrounding skin is carried out and sterile dressings applied. Active mobilization of the joint follows along lines already shown. Moreover, even in cases complicated by considerable fracture, mobilization must not be postponed, for serious loss of joint function may ensue. This practice is considered particularly important where the fracture lines are extensive within the joint.

If the bullet is retained within or impinges upon the joint, it must be removed, the Hirtz compass being a satisfactory instrument of localization. The joint cavity is then washed out with saline and ether and immediate suture done. If the bullet is lodged in soft tissue in a reasonably accessible place, it should be removed; if in bone, it should always be removed, as a rarifying osteitis frequently forms around it. A bullet may, however, remain impacted in bone for a few weeks without causing symptoms or disturbance.

b. *With much loss of soft parts or bone.* In certain rare instances a bullet at very close range (frequently self-inflicted) or a spent bullet, may cause marked laceration of soft parts or bone and sometimes both, complicating a joint injury. Under these conditions the whole procedure is exactly the same as if the injury had been caused by an éclat. The bullet itself should be removed.

III. *Wounds by sharp instruments.* Bayonet wounds or any other accidental incised wounds into the joint are very rare, only one having been encountered by Delrez in the past six months. An excision is done of soiled and injured tissue and the joint irrigated with saline followed by ether. Primary closure is made without drainage and immediate active motion is used.

The best functional results seen by us have been cases with knee-joint injury in which immediate suture gave primary union, and active mobilization a splendid movable joint. The poorest results encountered have been those of the wrist and ankle. Dr. Delrez has kindly furnished me his statistics during July, 1917, in 67 cases of wounds of the knee. The data follow:

24 cases without any lesion of bone; complete recovery, primary union and a good functional result in all cases.

30 cases with a bony lesion in which primary suture was made. Complete recovery with satisfactory joint function in 21 patients. Four developed a purulent arthritis and resection was performed. Seven cases had excision of the patella done and 6 of these were included among the 21 satisfactory results. One of the examples of resected patella was included in the cases of purulent arthritis. There were 5 deaths in this group with bony lesion, the cause being shock or some other complication.

13 cases with grave bony lesion. The injury in each of these cases was so extensive that amputation was necessary.

It is important to add, that in this particular series the injuries as a rule were of an extremely grave character resulting from the violent offensive upon that sector of the front.

Although the treatment outlined by Willems has yielded excellent results during a six months' trial at La Panne, the methods advocated and used by most surgeons suggest the possibility of a more conservative course being followed. Some points of especial interest wherein accepted surgical principles, based upon experience, may be at variance with the Willems treatment, may briefly be considered.

All now generally agree that primary closure of joints is of vital importance, but the principle of immediate active mobilization still has not received general acceptance. It is possible that the immediate active movement may interfere somewhat with wound healing and increase the liability to infection. A slightly longer period of postoperative rest for the joint may, therefore, be desirable. One case of shoulder-joint injury from which

Fig. 1. Modified Thomas split showing support for transportation and cut out for dressing, with one bar of cut out removed for dressing and with both bars removed for dressing.

an éclat was removed by one of us, with primary suture and tube drainage of the soft parts for 16 hours but *with active movement deferred for 10 days*, gave an excellent functional result. It seems possible, therefore, that the principle of reasonably early joint movement may prove the better one.

Resection of the knee is still done by many surgeons where partial primary suture is attempted by the new method. A movable closed knee joint, wobbling to such a degree as to need a permanent apparatus to control a marked lateral mobility, may very possibly be less desirable than a stiff resected joint.

General experience has been favorable to the use of Carrel solution in soft tissues. The use of dry gauze, in open wounds of soft parts, with partial primary suture of joints, is not generally followed.

In cases of joint injury complicated by fracture the generally accepted practice is to immobilize the joint for a considerable period, that the fractured bones may be maintained by proper alignment.

Nevertheless, the results attained by Willems, Delrez, and others, seem to justify their enthusiasm for primary joint suture followed by immediate active mobilization, and to place the treatment on a fairly well established basis.

IV. *Acute purulent arthritis.* In the earlier days of the war, the treatment of acute suppurative arthritis followed the lines laid down in civil surgery, namely, wide exposure of the joint, frequent irrigation, and absolute immobilization. Later Carrel-Dakin was used in joints with the hope of rendering them sterile and amenable to secondary suture, but save for a few instances, the cases did badly and many ultimately came to resection or amputation. A little less than a year ago Willems inaugurated a new method of treatment for these patients. Later other surgeons also began to work according to methods outlined by Willems, and in July, 1917, Delrez began his work at La Panne. The principles of this treatment are briefly as follows:

1. The knee and elbow are usually opened laterally. Some cases, however, of knee-joint infection, where the opening has been made of necessity, anteriorly and posteriorly, have done equally well.

2. Use no drainage material, as it will prevent drainage and carry infection into the joint.

3. Employ no irrigations into the joint. They may introduce infection.

4. Hot dressings are applied for the first 48 to 72 hours, changed every two to three hours if very considerable joint swelling and local reaction follow the operation. This is a special feature of the joint treatment at La Panne.

5. Active movement of the joint from the very beginning should be carried out at frequent intervals during the day, which practically means as often as every hour or two. The patient is wakened two or three times during the night and induced to practice active movement of the joint.

The essential element in this plan of treatment is the immediate and continued active mobilization. It is maintained that the joint will drain itself if active movements are faithfully persisted in. Even though the patient is quite ill with high temperature the routine of joint motion is conscientiously carried out. In the average case the patients are quite uncomfortable in the early weeks. The course may be long and tedious, extending even over several months. The utmost patience therefore must be exercised by the surgeon in his management of the man and his lesion. Cessation of movement is usually followed by accumulation within the joint, associated with increased pain and temperature reactions. No splint is used, but support of the extremity may be furnished by a sling

or vertical traction attached to the Balkan frame. The results obtained at La Panne seem to justify to a considerable degree this plan of treatment. The method is certainly very interesting, but final judgment upon it must be reserved. It is possible that the pendulum may swing back a little toward the pre-war accepted practice of treating acute purulent arthritis. We are inclined to believe, however, that the method of active mobilization may offer more for the patient as to life and function than any yet devised.

In conclusion, the writer desires earnestly to record his appreciation of the friendly advice, helpful suggestions, and kindly criticisms of Dr. Delrez.

SURGERY OF THE HAND (LEE)

Wounds of the hand are among the most frequent met with in the field of war surgery, and therefore constitute an important surgical problem. Appropriate treatment applied early will yield excellent functional results in many cases. The watchwords are *conservation of tissue, primary suture, and early active movement.* The simple injuries heal rapidly and allow a quick return to duty. Provision should be made, therefore, for proper treatment of this group close to the front. The more serious types of lesion, however, require a long period of convalescence and are frequently permanently disabling.

The local preparation for operation is accomplished with razor, scrubbing brush, soap and water, under a general anæsthetic, which is always necessary for operation upon the hand. This cleaning up must be thoroughly done, for the skin of the hand is always dirty. The nails should be cut short. Ether and tincture of iodine are freely used for the skin of the entire hand with a generous amount of the iodine under and about the nails.

Excision of tissues must always be made with a wound of the hand by éclat, fragments of shell, grenades and bomb, and also by a rifle bullet at very close range. If this rule is not followed, the course after non-intervention is usually unsatisfactory. The wound suppurates, operation is necessary and the course is often long drawn out. Operation is not done in the case of a through-and-through bullet wound. Removal of a retained foreign body is the rule save with a retained minute fragment which may cause no trouble.

The incision for the dorsum of the hand is made in a longitudinal direction; for the palm, generally longitudinal, unless special indications require an incision parallel to the skin folds.

Conservation of skin, muscles, and tendons is important. The surgeon must constantly observe this precaution, for wide removal may leave considerable dead space and thus interfere with healing and function; the barest edge of skin is sacrificed. A curette is always used in the depth of the wound to remove bits of foreign material and injured muscle. If a fracture is present, the injured bone is curetted and loose fragments likewise removed. With wounds on both palm and dorsum, following excision of a seton injury, a small piece of gauze drawn through the wound may aid in removing foreign materials, injured muscle or bits of loose bone. Irrigation with saline further assists in floating out minute pieces of bone or other retained débris.

Immediate suture is done in the hand, wherever possible. This may be made under conditions which would cause one to hesitate with wounds of other soft parts. If doubt exists as to the primary healing, the wound should not be tightly closed, and if it is thought wise, a minute drain may be used for 12 to 24 hours. In other cases, where complete primary suture is not accomplished, delayed primary suture in 1 to 3 days frequently succeeds, the surgeon being guided in its use by bacteriological wound examinations. The daily dressings before the delayed suture are usually made with dry gauze.

Early active movements of the hand and fingers are essential to a rapid recovery and a useful functional result, and the patient is encouraged to persist in these movements. *Small dressings* of gauze held in position by adhesive facilitate these movements. One must constantly bear in mind that although the wounds of the hand may be small and

trivial, all dressings must be done under the best type of surgical technique. A splint should be used if fracture without joint involvement exists, the treatment of the fracture following accepted lines of civil surgery. When fracture into a joint is present, the surgeon must decide in each case as to the wisdom of early active motion or immobilization. The finger wounds follow the same principles as those laid down for the hand.

One special procedure advised and used at La Panne by Dr. Delrez is worthy of mention. With an injury of the thumb requiring amputation at the metacarpophalangeal joint, and a coincident loss of the index and middle fingers, including the second metacarpal bone, he believes that a more useful hand is obtained if the third metacarpal bone is also sacrificed. This gives a thumb stump with an intervening space between it and the fourth finger, and provides a useful grip, not possible when the third metacarpal bone is preserved.

SURGERY OF THE FOOT

The general principles established for the hand hold here also. Some essential points of difference exist, however, changing somewhat the details of treatment.

The *incisions* are in general made *longitudinally*, but they must be definitely more ample. The foot is thick, and wide exposure is necessary to make a proper excision of injured soft tissues. If the through-and-through wounds are far forward, it is usually better to prolong the incision through the web between the toes, thoroughly exposing the whole damaged area. A seton wound near either lateral border of the foot is best treated by a *transverse incision*. No important structures are thereby divided, injured soft parts are readily reached, and subsequent closure is satisfactory.

The conservation of toes is less important than the saving of fingers, and frequently a quicker and better functional result will be obtained if the toe is sacrificed.

Primary suture is the almost invariable rule to be followed.

In wounds complicated by fracture of the os calcis, after the usual excision of soft parts, and removal of detached bone fragments, primary suture is generally attempted. The very serious foot lesions, however, must be left open, with at most a partial suture done. Some of the cases require immediate amputation.

The need for early active movements is less urgent than with the hand, but the same desire for rapid restitution of joint function is present. A longer period of rest and immobilization is, therefore, generally allowed.

CARREL TREATMENT (DINEEN)

For routine ward dressings the doctor is assisted by one nonsterile nurse and one orderly. A dressing carriage contains all essentials. The doctor should scrub up with the same precision and care as for an aseptic surgical operation. He should put on a sterile gown and wear sterile gloves. It is impossible at a front hospital to follow the same elaborate system as to draping the wound, having numerous assistants, etc., as in a civil hospital, or in a large institution far from the front.

We will presuppose that we have to deal with a wound of the limb which is surrounded by large pads as the outer, and gauze as the inner dressing. The large pads completely encircle the part and are secured by safety pins.

A description of a typical dressing follows: The nurse has a long pair of sterile dressing forceps that are kept in a narrow necked bottle of 95 per cent alcohol, only the handle protruding. The soap, water, and the Carrel Dakin solution are kept in small sterile basins. A pair of sterile dressings forceps is passed, handle foremost, by the nurse. The nurse removes the safety pins from the outer pad. The surgeon turns back the pad, allowing it to fall away from the wound. The nurse then passes a rubber sheet under the wounded part. All dressings not in direct contact with the wound are removed by the surgeon. A new pair of dressing forceps is then passed and the Carrel tubes and deep dressings are removed. The wound is carefully draped. Theoretically the draping should be done as for an operation; practically this is not possible for reasons of economy. Cultures

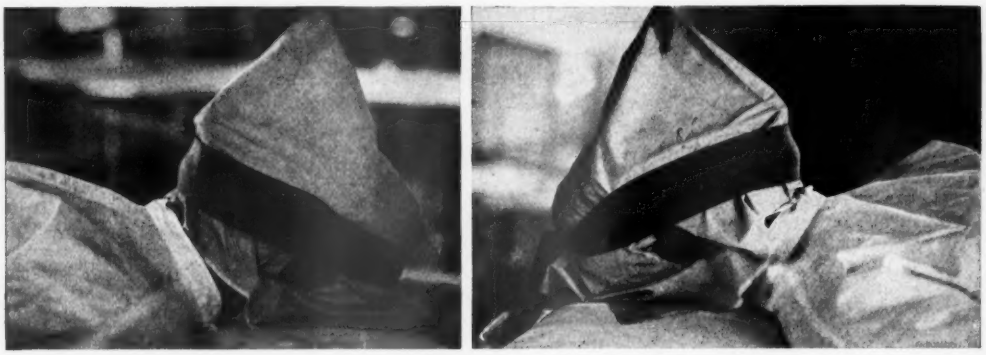

Fig. 2. *A* (at left), Anæsthesia mask *in situ*. *B*, Mask in position showing hole at top of mask for admission of air and additional anæsthesia.

and smears are made before the vaseline gauze is removed. This avoids skin contamination. It is a mistake to make the smear, or pipette the culture from the purulent looking Dakin solution in the bottom of the wound, because very frequently the organisms contained therein are dead and of no use for media inoculation. It is better to remove this fluid with a tampon. Then a small tampon or pledglet of cotton is gently but firmly rubbed across the wound, smeared on a sterile dry slide which is flamed by the nurse. The nurse then passes by means of the long sterile forceps, tampons soaked in soap solution, being careful that the doctor's forceps do not touch hers, and that the exchange is not made over sterile receptacles, since drippings contaminated by his forceps would vitiate the technique. A receptacle is provided for the soiled dressings; the exchange of wet articles should be made over a small basin.

First the skin is cleansed with soap, warm water, and brush if necessary. It is shaved every third or fourth day with a sterile razor, from wound to periphery. The razor is returned to the nurse, cleaned, and placed in a tray of 95 per cent alcohol. The wound is then carefully cleaned and irrigated. For the irrigation, there should be a tank of sterile water, with a faucet outlet, to which is attached a long piece of rubber tubing. The last foot or two of the tube lies in bichlorid of mercury solution. The end of the tube is passed by the nurse with her sterile forceps. In one hand the surgeon holds the irrigation tip and irrigates the wound, while in the other hand he holds a pair of dressing forceps, and with a tampon removes shreds of fibrin, gauze, and other extraneous material. The irrigation finished, the water is allowed to run out of the tube before it is returned to the bichloride solution. The nurse then passes sterile tampons with which the wound is sponged, and the skin thoroughly dried. The skin is then sponged with ether. At this point the surgeon discards his forceps, and receives one pair of dissecting forceps without teeth and a pair of dressing forceps. These instruments give the surgeon the best control. The vaseline gauze, kept in a sterile tin box is passed, piece by piece. The gauze is taken by both ends, one inch from its border and drawn along the skin to the wound edge thus folding in the margin. Then the gauze is held fixed with the plain forceps and quickly smoothed out with the dressing forceps by one long sweeping stroke. The folding of the gauze prevents frayed edges and loose threads from coming in contact with the wound. Two details add considerably in applying gauze in inaccessible regions. first, to have the part dry, and second to use only one layer of gauze which should be well saturated with vaseline. The nurse passes the Carrel tubes. It is absolutely necessary that every little cavity be sought out and tube inserted, for every bacterial focus must be

reached. The distal ends of the tubes may be attached immediately to the Carrel bracket. The tubes should be so inserted that no holes are outside of the wound. Occasionally a sterile bandage is required to hold the tubes in place. Moist Carrel compresses are placed over the whole wound. A dry gauze dressing is applied over the whole area. The outer dressing pad is drawn tight, and fixed by the nurse with safety pins, after she has removed the rubber sheet.

Between cases the gloved hands are thoroughly washed in bichloride of mercury solution.

The vaseline gauze is prepared as follows:

Strips of gauze 8 by 3 inches are cut, and arranged in layers five pieces deep. The first layer of five is covered with vaseline. Then five more pieces are placed on top and covered with vaseline, and so on until the required amount is made. The gauze is placed in a tin box which has been smeared thickly with yellow vaseline on the inside. The cover is applied and a bandage tied around to keep the cover in place. The box is then placed in the autoclave 120° C. for one half hour.

ANÆSTHESIA (DINEEN)

Anæsthesia plays an important part in the surgery of the war; many fatalities can be attributed to it. A considerable number of patients are in shock, they have lost much blood, their nerve centers are in an unbalanced condition due to the life in the trenches, and their general physical condition is often lowered by hardships, privations, and restrictions. This is the type of patient which often comes to operation, and a skillfully administered anæsthesia is strongly indicated. Each case must be carefully studied, observed, and followed. Another point must be strongly emphasized. Many of these patients are admitted very shortly after meals and must be operated on immediately. If it can be established that the patient has taken food within one and a half to two hours before admission, the stomach, if possible, should be emptied before anæsthesia. The importance of this is shown by the fact that many of these patients vomit large quantities of food remnants during the anæsthesia, and the fact that aspiration pneumonia occurs in an appreciable number of cases. Dr. Sands has found in 57 consecutive autopsies, 4 pulmonary infarcts, 17 bronchopneumonias and among these, 5 were aspiration pneumonias; food particles were found in the lung on microscopic examination.

Fig. 3. Anæsthesia can be prolonged by the addition of ethyl chloride in the hole at top of mask.

General anæsthesia. Ether is the safest and best available anæsthesia for routine use. It may be given either by the open drop method or by the closed method. For the latter the apparatus of Ombredanne is generally employed in Belgium and French hospitals. Chloroform is the choice of some surgeons, but it is dangerous. Gas and oxygen is not used to any extent. There can be little doubt, however, that this combination would be almost an ideal form of anæsthesia for many cases, as so large a proportion of these wounds are of the extremities, and complete relaxation is not required.

War surgery necessitates the dressing of many painful wounds. A brief anæsthesia that affords the surgeon an opportunity to do his dressing thoroughly is a necessity. Savariaud, a French Surgeon, has devised a method of securing anæsthesia that has proved very satisfactory, though it is not wholly devoid of danger. For its best results

very careful supervision is necessary. The mixture consists in general of 18 cubic centimeters of ether, 10 cubic centimeters of ethyl chloride, and 2 cubic centimeters of chloroform.

According to the duration of the operation the mixture is proportionately increased or decreased. The apparatus for giving this anæsthesia consists of a hood of some impermeable material as oil cloth, oil silk. The material used by Savariaud is *jacquonnette*. The hood measures 39 centimeters in length on each side, and 29 centimeters wide, and has a small opening on top. (See photograph.) Flannel, two pieces each 32 centimeters square. A rubber bandage (Esmarch bandage).

Method of procedure. Into a graduate 2 cubic centimeters of chloroform are accurately measured; then eighteen cubic centimeters of ether are added and finally 10 cubic centimeters of ethyl chloride. The receptacle must be covered tightly since the mixture, particularly the ethyl chloride, is very volatile. The fluids are added in the above order because the chloroform is the least volatile and the ethyl chloride the most. No time must be lost from start to finish, or the force of the anæsthesia is much diminished, thus seeming to emphasize the fact that the ethyl chloride is the most potent ingredient. The mixture prepared, one of the pieces of folded flannel is placed over the top of the graduate to prevent rapid evaporation. The anæsthetist is now ready to give the anæsthesia. One piece of flannel, not folded, is placed over the patient's face, completely covering it. Then the mixture is poured over the other pieces of flannel which the anæsthetist has been holding over the mouth of the graduate to prevent evaporation. This second piece of folded flannel is then placed over the nose and mouth, and the hood quickly applied. The ears stick out through the two holes on the sides so that their color can be readily observed. The elastic band to secure the hood is then applied from chin to occiput. For this, take the point of the chin and there apply the middle part of the bandage; run the band upward (keeping the band flat) just anterior to the ears and back to the occipital protuberance before tying the bandage. A good purchase is thus secured, and the mask will not slip off. Plenty of space must be left between the flannel and the hood for a rebreathing chamber.

By this method the operator can himself apply the anæsthetic and then quickly return to the dressing, or better, a nurse administers the anæsthesia and may then assist the surgeon. The patient is under the influence of the drug in from 30 to 60 seconds and remains under for a varying length of time, from three to twenty minutes, so that small operations can be easily performed. The anæsthesia may be prolonged by the addition of ethyl chloride through the whole at the top of the mask (Fig. 3). The average time for the painful part of the dressing is about three minutes and the mask is completely removed as soon as this is finished.

The anæsthesia is convenient and satisfactory and under careful supervision fairly safe for routine dressings. But the anæsthesia should be carefully watched throughout, and the mask removed at the first signs of respiratory embarrassment, which is usually the first indication of trouble. In the absence of other assistants the operator or the nurse assisting at the dressing can adequately follow the anæsthesia.

Local anæsthesia. Cocaine and its derivatives, particularly novocaine, are used considerably in plastic face surgery with good results. Extraction of foreign bodies from the brain, trephining and plastics may be done without much shock, or discomfort to the patient. Ethyl chloride is very little used for local anæsthesia.

Transfusion. So many of these patients are in shock and markedly exsanguinated that we are impressed with the frequent necessity for the use of transfusion as a life-saving measure. The type of procedure used will vary with the operator. The important practical point is to provide a constant supply of available donors, and the group of each donor established. If one has the serum of groups II and III a patient's grouping is readily determined by a simple agglutination test. See accompanying chart for the interreaction of the various groups.

AGGLUTINATION CHART

Serum	CELLS I	II	III	IV	Per cent
I	o	o	o	o	8
II	+	o	+	o	40
III	+	+	o	o	10
IV	+	+	+	o	42

The wisest plan is to use only group 4 donors, as this makes grouping of the recipient unnecessary. The cells of IV give no agglutination with any of the four sera, while the serum of groups II and III protects its own cells against hæmolysis by the IV serum.

In the operating-room a small transfusion donor list is posted, available immediately in an emergency.

The details of the method are given in an article by Major Lee, British Base Hospital No. 12, in the *British Medical Journal*, November 24, 1917.

THE TRANSPLANTATION OF BONE IN THE REPAIR OF CRANIAL DEFECTS

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Loss of substance in a skull bone was so rare, previous to this war, that it was seen only occasionally where trephining had been performed for fracture of the skull or decompression for some intracranial lesion. During the past three and a half years the number of cases suffering from cranial defects has been rapidly increasing, probably resulting from the modern system of trench fighting. The injuries to the skull have, like wounds received in other parts of the body, been practically always infected, often being complicated by a foreign body lodging in the meninges or brain substance. This condition has necessitated free removal of bone either at the Casualty Clearing Station or base hospital according to the methods of Sargeant (1) or Cushing (2), and the patient arrives in England with a wound which is usually healed completely or may have a small discharging sinus.

This hospital receives cases directly from France and also transfers of Canadians from Imperial Hospitals. On January 1, 1918, the surgical service of this hospital had under treatment 1317 cases, of which 1031 had been admitted in convoys from France, the remainder having been transferred from hospitals in England. From examination of the 1317 cases, 28 were found to be suffering from cranial defects. Of these 28 cases, 16 had been admitted in convoys from France and 12 had been transferred from Imperial Hospitals in England. From these figures it will be seen that the average of cranial defects admitted to this hospital is over 2 per cent of the total surgical casualties.

This report is based upon 20 cases in which we performed a bone-grafting operation for the repair of cranial defects. The practical use of bone graft has been a subject of much study to surgeons for more than a century. Professor Arthur Keith (3) has recently pointed out to us that John Hunter was one of the pioneers in bone grafting and fully realized its usefulness and value but failed to carry it to a successful issue on account of sepsis. In 1867 Ollier, of Lyons, published an important work in which he proved that transplanted compact bone could live without its periosteum. Recently Major Hey Groves (4) has published a review of the work performed by Ollier, Barth, Axhausen, and Macewen during the past three decades and in the same article published the results of his own experiments with the grafting of bone in cats. A careful analysis of their work shows that they all agree on several main points.

1. That compact bone can live and proliferate when transplanted.

2. That periosteum does not reproduce bone.

3. That the viability of the graft is increased if both periosteum and endosteum have been retained.

In 1914 Gallie (5), of Toronto, published a report of a series of interesting experiments. The conclusion he arrived at, as a result of these experiments, was that grafted bone dies, but at the same time acts as a scaffold which becomes vascularized and which is invaded by osteogenetic cells from the host. From these invading cells new bone is produced. That grafted bone does not die, as Gallie believed, has been proved in a case reported by Sir Robert Jones (6) in which he had transplanted a long strip of tibia from the sound limb into the epiphyseal ends of a tibia whose shaft had been removed for osteomyelitis. The graft united to the host and grew rapidly according to Wolff's law and the case was discharged from the hospital. Six months from the time of the grafting operation, the patient was knocked down by a bus and the grafted bone fractured in the center. The case was again under the care of Sir Robert Jones who had a series of roentgenograms taken during the recovery. These pictures show callus forming at the point of fracture, and firm union resulted within the average time allowed for normal bone. Albee (7) has reported a large number of cases in which he has performed his sliding-graft operation in simple fractures of the long bones. Roentgenograms taken later show firm union between the graft and the hosts. Sir William Macewen (8) reports a case in which he removed a large piece of a parietal bone when operating for the relief of cystic intracranial disease. The bone was preserved in warm saline solution for half an hour and then re-implanted. Five years later the patient died from a pulmonary condition and on reflecting the scalp it was found that firm osseous union had occurred between the re-implanted bone and the skull.

McWilliams (9), in his review, concludes that the survival of a graft depends on the establishment of a sufficient blood supply and that blood supply is more quickly and efficiently established when both periosteum and endosteum are transplanted. Of the different theories advanced on the growth of bone, it is now generally conceded that the one taught by Sir William Macewen is the most conclusive. Macewen proved in his experiments that periosteum does not reproduce bone but merely acts as a limiting membrane and that new bone is formed by the proliferation of osteoblasts within the grafted bone itself and quite independent of the periosteum.

As a result of the conclusions of these investigators we believed that a very extensive field had opened where bone could be used in the repair of cranial defects. It will be seen by the statistics of this hospital alone that the number of cases in which there has been a loss of bone substance will average fairly high in the total casualties. It is realized that a cranial defect usually makes a man unfit for any active occupation and indeed, judging from the marked degree of depression, suffering, and fear seen in many of these cases, they will become wards of the State during their lifetime. Realizing this, we have endeavored to develop a form of treatment which will help these men to become an economic part of the man power of the nation and not mere helpless dependents.

To ensure a successful result in our transplanting of bone we found there were several fundamental principles to be carried out in all cases.

1. No graft should be attempted until all discharge had ceased and the wound had been perfectly healed for three months. This time differs from the period we wait after the healing in long bones. In compound fractures of the long bones we insist that the wound must be healed for at least six months before operating. However, we have found that operations on the skull can be performed after a waiting period of three months without fear of stirring up a latent infection. The great vascularity of the scalp is probably responsible for this difference.

2. Most careful aseptic technique both in preparation of patient and during operation.

3. The graft should be autogenous, the crest and inner surface of the tibia being most suitable.

4. The periosteum of both the host and grafted bones should be retained, as well as some of the endosteum, in the graft.

Fig. 1. Series of cases showing cranial defects.

5. Close apposition and immobilization of graft into host.

6. Small drainage tube in one corner of the wound for twenty-four hours to allow drainage for the slight oozing which is impossible to control in the flap.

In studying the case sheets of this series it is found that consciousness is lost at the time of injury in a large percentage of cases and is not regained for some hours, at least, and indeed often persists for several days. The notes on the field medical card accompanying the man, although brief, usually give most valuable and interesting data, as it is from this we learn the extent of injury and the form and type of treatment carried out. When these cases are evacuated to England some weeks have elapsed and they are convalescent from their first operation.

On examination of the head a loss of bone substance is found, usually showing a definite depression which markedly pulsates. The scar and area around the depression are sensitive and painful to touch. On interrogation, the patient's cerebration is found to be slow and the memory poor. A constant symptom is an extreme degree of depression, often associated with fear, the fear being probably due to an apprehension of further injury to the pulsating cavity. He appears drowsy and lacks initiative. Severe headache is present in all cases. The headache is usually aggravated by movement. The headaches may be intermittent or of a continuous character, but even in the intermittent type the man is never free from pain for more than a few hours. The constant headache is no doubt due to the dura mater, which is almost entirely supplied by the fifth cranial nerve, being firmly adherent to the old scar tissue and so under constant irritation. Motor aphasia was present in three of the twenty cases and epileptiform seizures occurred in three cases. Vomiting may occur, especially during exercise, and after vomiting dizziness is marked. In all cases there were very definite and constant eye symptoms. In every case there was an abnormal contraction of the color fields, sometimes being irregular and interlacing, at other times being entirely absent resulting in a complete color blindness. Blurring of vision with a slight choked disc was common. Partial hemiplegia or monoplegia, exaggerated reflexes, areas of anæsthesia and a marked abhorrence of noise have been found.

Technique of operation. Forty-eight hours before operation the head is shaved, great care being taken to avoid nicking the skin, especially in the vicinity of the old scar. The head is well washed with green soap and water, followed by ether and alcohol and a dry sterile dressing and cap applied. Twenty-four hours preceding operation the head, forehead and ears are freely painted with tincture of iodine, allowed to dry and a dry sterile dressing is again applied.

The anæsthetic is of the greatest importance, not only for the safety of the patient, but also that it may be administered in such a way that the anæsthetist will not obstruct the operator. In our first seven cases, rectal anæsthesia was used as follows: Two hours before operation the rectum was repeatedly washed until all fluid returned clear. One hour preceding, ¼ grain of morphine and 1/100 grain scopolamine was given hypodermically. To induce anæsthesia four ounces of ether was well shaken with two ounces of olive oil and this was slowly introduced into the rectum, at least ten minutes being taken.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 2. Case 1. Showing loss of bone substance.
Fig. 3. Case 1. Scalp reflected. Occipitofrontalis aponeurosis and pericranium still covering opening.
Fig. 4. Case 1. The occipitofrontalis aponeurosis and pericranium have been separated from dura mater and are held in tissue forceps. The dura mater is being freed from any attachment to the inner table.
Fig. 5. Martel's electric burr, beveling off outer table.

Surgical anæsthesia was present in 30 to 40 minutes. While the anæsthesia produced was all that could be desired, we decided after two unpleasant experiences resulting from shock occurring during the deep anæsthesia that a form of anæsthesia in which the patient could be permitted to "come out" quickly would be safer. Since then we have used an intratracheal method which is most satisfactory in all respects.

To expose our cranial opening, the horseshoe flap is used, making the incision at least one and a half inches from the edge of the bony opening. In bringing down this flap one of the most important points in the whole operation occurs. The primary incision must be made only through the skin and subcutaneous layer and the flap thrown back leaving the occipitofrontalis aponeurosis (galea aponeurotica) attached to the pericranium. This gives strength and an increase of blood supply to the pericranium, which will form the covering and part of the blood supply to the graft. After reflecting the skin flap, a longitudinal incision is made through the occipitofrontalis aponeurosis and pericranium over the skull opening, extending to at least one and a half inches to either side of the opening. At the site of the old scar, it will be found that the aponeurosis pericranium and dura mater are all matted together in a dense mass of cicatricial tissue. With care this scar tissue can be stripped from the dura mater providing that membrane has not been opened at the time of injury or first operation. The dura mater, which is

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 6. Case 1. Outer table beveled off. Diploe and inner table showing.
Fig. 7. Case 1. Bone graft immobilized.
Fig. 8. Case 1. Occipitofrontalis aponeurosis and pericranium have been sutured over graft.

Fig. 9.

Fig. 10.

Fig. 11.

Fig. 9. Case 2. Showing loss of bone.
Fig. 10. Case 2. Showing pericranium reflected, outer table removed. Sutures threaded through inner table.

Fig. 11. Case 2. Removal of one piece graft from tibia.

found firmly adherent to the edges of the opening in the bone, is then freed and a periosteal elevator passed under the bony margin to see there are no adhesions here. If the dura mater has been opened at the time of injury or at the previous operation it will be found to be so densely involved in the scar as to make it impossible to separate without opening. If it is found necessary to open the dura mater it is done by making a crucial incision freeing the adhesions to the cortex and turning back the corners. This opening in the dura mater is closed by grafting a small piece of fascia lata with some fat adherent to its surface. The surface containing the fat is placed against the cortex and the fascia lata tacked to the dura mater at the corners by four fine catgut sutures.

The bed for the graft is now made by beveling off the outer table for a distance of half an inch from the bony opening. To do this a Martel burr is attached to an Albee motor and the outer table is carefully removed, leaving the cancellous and vascular diploe from which the skull receives its main blood supply to act as a fertile bed to receive the graft. Two or three holes are now drilled through the inner table with Albee's electric drill, a metal guard being placed between the inner table and dura mater to prevent injury to the brain. Twenty-day chromic catgut is threaded through these holes to be used in immobilizing the graft. The head is now covered with warm sterile towels and left while the graft from the tibia is removed.

To remove the tibial graft the bone is exposed for at least eight inches, a flap being preferable. The inner surface of the tibia gives the best area. A graft, the entire width of this surface, an eighth of an inch in thick-

Fig. 12.

Fig. 13.

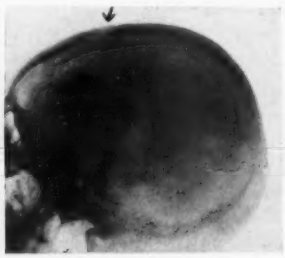

Fig. 14.

Fig. 12. Case 2. Immobilizing one piece graft.
Fig. 13. Showing graft six months after operation. Of the four holes drilled through the grafted pieces three have entirely disappeared.

Fig. 14. Showing graft five and a half months after operation. Plate showed definite callus around anterior and posterior ends of graft. Arrow indicates graft.

ness and retaining its periosteum, is removed by using a saw, the blade of which is narrow and can be turned to any angle.

On removal, the graft is immediately transferred to its bed in the skull. The graft is never placed in saline or other media as any foreign substance tends to devitalize the graft. The periosteal surface of the graft is turned toward the dura mater, only the area which will lie on the diploe being bared of periosteum. The periosteum is turned toward the dura mater for three reasons.

1. To provide a smooth surface with which the dura mater may come in contact.

2. The periosteum being a limiting membrane prevents any chance of an exostosis growing from the under surface of the graft and eventually causing pressure.

3. The endosteal surface of the graft will be covered by pericranium.

When the graft has been carefully immobilized by tying the chromic catgut, which has been threaded through holes drilled in the ends of the bone, the reflected pericranium and occipitofrontalis aponeurosis is carefully sutured over the graft, every endeavor being made to cover its entire surface. The scalp flap is now brought over and sutured with interrupted silkworm-gut sutures, a small drainage tube being left in one corner for twenty-four hours. Plenty of dressings and a firm head bandage or cap, which will give a fair amount of pressure over the operative area, are applied.

Some doubt may be expressed as to the probability of these grafts living. Macewen implanted nude bone shavings into muscle and peritoneum. In both cases they survived, one graft actually increasing in size. It has previously been pointed out that the grafts in long bones live and, as there is absolutely no difference between the osteoblasts of the skull and those of the long bones, it follows that we have no reason to doubt that successful results should follow the skull operation. We have seen by monthly roentgenograms that the holes drilled to immobilize our graft gradually disappear, proving that they were filled with granulation tissue, which was invaded by lime salts, ossification resulting. Five and a half months after the operation on one case we explored and on cutting through the pericranium found it firmly adherent to the graft, and on stripping it back the bare bone was seen to ooze freely. A small wedge-shaped piece of the graft was removed and the laboratory reported that the specimen was living bone, invaded by blood-vessels.

The advantages of bone graft over metal and celluloid plates are:

1. The bone lives and eventually becomes part of the skull.

2. It does not cause irritation or act as a foreign body.

3. An excellent effect is produced on the patient mentally.

Bone has the advantage over cartilage in that it retains its hardness and is as efficient a covering to the brain as the skull. Leriche and Policard (10) have recently reported that examination under the microscope of cartilage implanted to close cranial openings, in one case operated on 36 days and in the other one year previously, the cartilage proper had been substituted by connective tissue. We found in two cases in which we used cartilage that after five months the graft softened and did not give the same amount of protection as did bone.

CONCLUSIONS

We would draw special attention to the following benefits from operative procedure:

1. Depression leaves, patient becomes optimistic and bright.

2. Headaches improved in all cases; entirely absent in large percentage.

3. Memory improves, dizziness disappears.

4. Eye sight improves, the blurring of vision disappears, and the color fields increase.

5. The man ceases to be a permanent ward of the state and becomes a useful citizen, capable of carrying on any ordinary occupation.

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PROBLEMS OF THE RECONSTRUCTION OF THE HAND

By ARTHUR STEINDLER, M.D., F.A.C.S., Iowa City, Iowa

MUSCLE MECHANICS AND MUSCLE MECHANICAL PROBLEMS

RECONSTRUCTIVE surgery of the hand involves the following problems: (1) the work of the muscle and tendon reconstruction; (2) reconstruction of the peripheral nerves and re-establishment of the neuromuscular relations; (3) bone plasty, arthroplasty and autoplasty.

This paper deals with the first problem and its scope is to illustrate certain phases of muscle mechanics of the hand with proper application of the findings to clinical problems.

No matter how complicated and intricate the functions of the hand may become, they are subordinate to the most rigid mechanical and mathematical laws. The fundamentals of these laws are definitely known, having been worked out thoroughly for muscle mechanics in general, by the classical contributions of Fick (1), Weber (2), Strasser (3), Herz (4), Mueller (5), Rays (6), Frohse and Frankel (7), Virchow (8), and others.

The principal factors of muscle mechanics are: the volume of the muscle, the tension, distance of contraction, and the angle of application of force.

It would seem therefore that almost any musculomechanical condition could be worked out and calculated mathematically; but when in quest of such mathematical solution one is very soon aware of the fact that the problems become immensely complicated as soon as one departs from the most simple conditions.

Therefore, in introducing the fundamental mechanical values, the problems chosen had to be so simple as to be entirely hypothetical; at least so far as conditions applying to the hand are concerned.

All other facts have been arrived at entirely by experimentation, and carried out on anatomical specimens, carefully prepared. This involves the great disadvantage that all readings of numerical values are subject to many sources of errors caused by the great difference between the anatomical specimens and the actual conditions in life. For this reason all figures given are only of relative value, that is, in relation of muscle to muscle in the same specimen, and they are to be taken as such in the accompanying charts. Where absolute figures are given they are taken from investigations of very careful observers such as Frohse and Frankel (7), and others.

Acknowledgment is due in this work to the very valuable co-operation of my assistant Dr. E. E. Hobby; also to Dr. H. J. Prentiss, professor of anatomy, who most generously put at our disposal the ample material of the institute.

JOINT MECHANICS

The carpal joints represent a central ginglymus which essentially carries flexion and extension movement. According to Virchow (8), the scaphoid moves in flexion and extension movements with the distal row of the carpal bones. The carpal joint of the radial side, formed by the scaphoid, trapezium and trapezoid shows gliding motion in radial as well as ulnar abduction.

Since the scaphoid moves with the distal row in flexion and extension but with the proximal in abduction movement, the mechanical center of the hand for all motions must be located in the center of the os capitatum and here the center of the entire

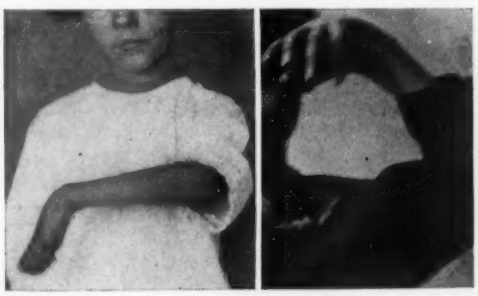

Fig. 1 (at left). Case 1. M. W. Volkmann's contracture.
Fig. 2. Case 1 after operation.

Fig. 3.

Fig. 4.

Fig. 4a.

Fig. 3. Case 2. L. McC. Spastic contracture.
Fig. 4. Case 2 after operation.

Fig. 4a. Tendon fixation for purpose of hyperextension. (Specimen.)

system must be placed. This is important if one endeavors to calculate the action of each muscle flexing and extending the hand upon the stabilization or mobilization of the wrist-joint. It is clear that the sum total of work done by any muscle equals at any point the product of amount of contraction and the middle tension of the muscle (Strasser, 3).

Fig. 5 (at left). Case 3. L. M. Spastic contracture.
Fig. 6. Case 3 after operation.

The action of any muscle upon the joint at any point must be divided in two functions; namely, that of stabilizing the joint and that of moving the joint bodies against each other. Geometrically these functions are represented by two components into which the sum total of the muscle action is resultant as divided (Chart I).

If m represents the resultant of force, the component a, rotating the joint and the component b, stabilizing the joint, will have the following values respectively in regard to m.

$a = m.$ sine $a.$

$b = m.$ cosine $a.$

In other words since sine a is greatest at 90 degrees and cosine a is greatest at 0 degrees, the muscle is at its maximum stabilizing power when parallel to the long axis of the joint and its maximum rotating power when at right angles to its insertion.

Now in this investigation the author tries to show first of all that stabilization of the wrist in extension or slight hyperextension is of prime importance for all functions of the

Fig. 7 (at left). Case 4. V. M. Paralytic drop hand (contracted.)
Fig. 8. Case 4 after operation.

hand. If this is so, anatomical conditions of the hand should be found to be in keeping with this principle; that is, we should expect the extensor muscles of the hand in such numbers as to insure stabilization of the hand in this position.

According to Frohse and Frankel (7), the numercial values of muscle weights for the hand are as follows:

1. Flexors of the wrist only:
   a. Flexor carpi radalis, weight 17.8 grams, fiber length 5.8 cm.
   b. Flexor carpi ulnaris, weight 21.4 grams, fiber length 4.8 cm.
2. Extensors of the wrist:
   a. Extensor carpi radalis longior, weight 25.9 grams, fiber length 7.6 cm.
   b. Extensor carpi brevior, weight 24.2 grams, fiber length 5.6 cm.
   c. Extensor carpi ulnaris, weight 14.4 grams, fiber length 5.3 cm.

Also acting as extensors due to connection with second metacarpal are:

   a. Extensor pollicis longus, weight 13.5 grams, fiber length 4.7 cm.
   b. Extensor indicis propius weight, 5.7 grams, fiber length 5.1 cm.

There is, therefore, in the first place numerical predominance of the extensors of the wrist over the flexors, whereas, on the other hand, the flexors of the fingers greatly predominate over the extensors of the fingers.

What this predominance means in the given figures, becomes clear when one considers the second fundamental principle of the

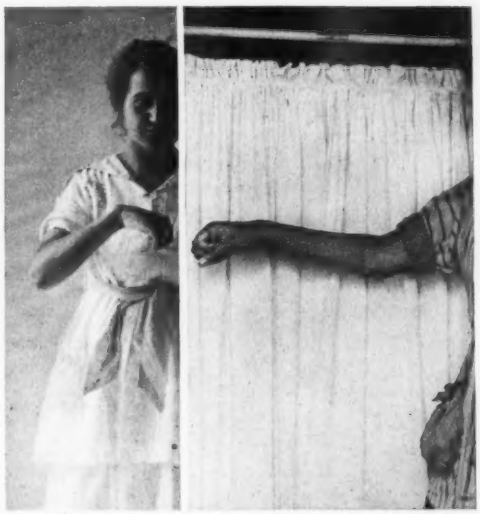

Fig. 9 (at left). Case 5. B. C. Flexion ankylosis wrist.
Fig. 10. Case 5 after operation.

muscle action and that is the tension of the muscle.

The tension of the muscle is a direct function of muscle weight and fiber length.

$$\text{Tension} = \frac{\text{weight}}{\text{length x specific gravity x k}}$$

k being a constant equalling 10 kilograms for 1 square centimeter, cross section area; and specific gravity being so nearly 1 in living tissue as to be negligible.

Substituting in this formula the figures given for weight and length of each muscle would therefore result in the conclusion that, in rough numbers, the combined tension of the extensors of the wrist is to the combined tension of the flexors of the wrist as 14 to 7 or 2 is to 1. In other words, the anatomy of the wrist is characterized by decided predominance of the extension power in the

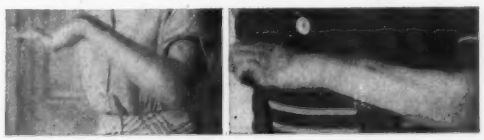

Fig. 11 (at left). Case 6. F. A. Contractures of wrist and fingers.
Fig. 12. Case 6 after operation.

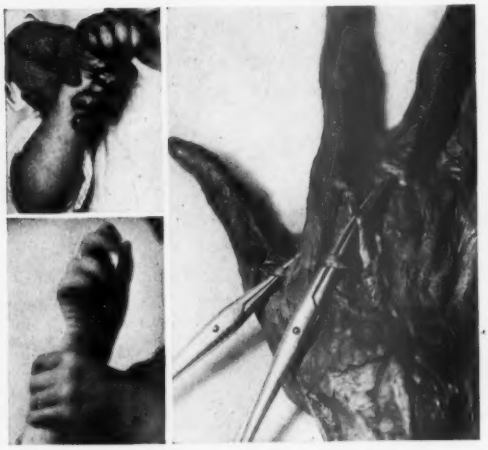

Fig. 13 (above at left). Case 7. V. P. Spastic contracture.
Fig. 14 (below at left). Case 7 after operation. Note action of thumb.
Fig. 14a. Tenoplasty to improve extension of thumb (Biesalski-Mayer). (Specimen.)

wrist. This extension in the wrist is, as we shall see presently, the one fundamental requisite which guarantees for the fingers the optimum of flexion power in the meta-

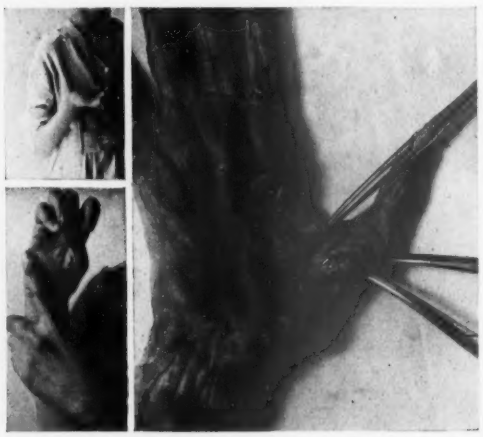

Fig. 15 (above at left). Case 8. F. B. Paralytic claw hand.
Fig. 16 (below at left). Case 8 after operation. Note opposition of thumb.
Fig. 16a. Tenoplasty; opposition of thumb obtained by transplanting one-half of flexor pollicis longus. (Specimen.)

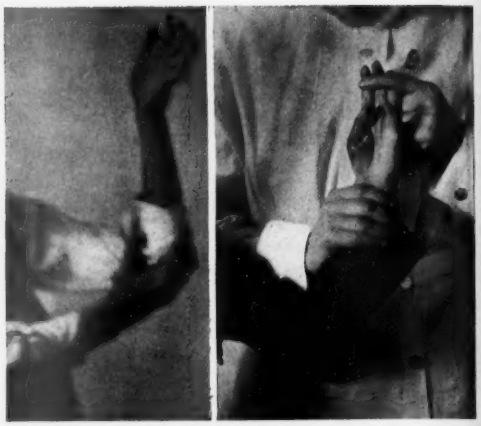

Fig. 17 (at left). Case 9. L. D. Vollmann's contracture. Wrist straightened operatively.
Fig. 18. Case 9. L. D. after operation of thumb. Note opposition of thumb.

carpophalangeal and the phalangeal joints, or in other words, the position which enables the fingers to display the highest amount of gripping power.

This point has been made the object of experimental studies. By observing the amount of contraction of the fingers both in extension and flexion of the wrist, numerous readings have given me values which are represented in Charts 2 and 3. These curves are called sine and cosine curves respectively, showing what each muscle will do in regard to stabilizing or moving the wrist-joint according to the position of flexion or extension in which the wrist is placed. But it is not only necessary to consider the mean tension of the muscle but also the fact that the muscle tension constantly decreases with increasing contraction. In the so-called middle position of the joint the muscle is in a state of tension midway between its maximum in full extension and its zero point in full contraction. Only by considering this tension one can realize the necessity of hyperextension in the wrist for the display of flexion power in the fingers.

Chart 4 shows the numerical values for contraction of the muscles both in flexion and extension of the wrist.

As the wrist is placed in complete flexion

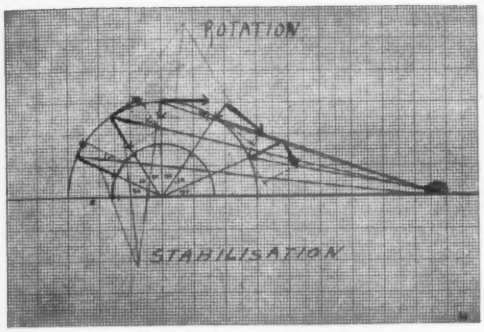

Chart 1. Shows rotation and stabilization components.

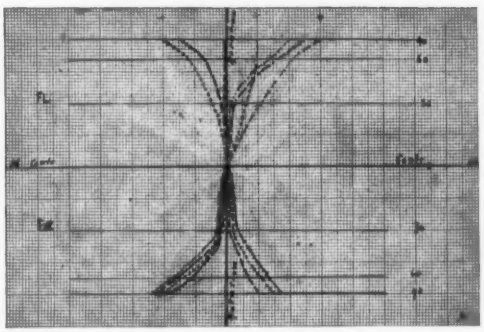

Chart 2. Sine curve of muscle action; showing mobilizing power of muscles of wrist; maximum at 90 degrees.

the amount of contractibility of the flexor muscles is already used up leaving only one-half to one-third of total contractibility of the muscles for the flexion of the fingers. The absolute amount of contraction of the finger flexors is not greatly different, whether finger flexion is carried out in extension or in full flexion of the wrist; but the fundamental difference is that as the wrist is placed in extension the following contraction of the finger flexors travels through the field of optimum tension of these flexors; with the wrist flexed it travels through the field of minimum tension. In the first instance contraction takes place nearer the point of complete extension of the muscles, in the second instance nearer the point of complete contraction of the muscles.

Chart 5 shows the diagram of this condition, 3 and 4 being the tension field of flexion, 3a and 4a the tension field in extension of the wrist. From this it will be seen that the absolute muscle power displayed by the finger flexors is many times greater in extension of the wrist than it is in flexion of the wrist. From this point of view all flexion contraction or deformity of the wrist have been dealt with no matter what the underlying conditions.

VOLKMANN'S CONTRACTURE

In cases of Volkmann's contracture the forced flexion of the wrist is evidently the starting point for all disturbances of the muscle equilibrium. The history of the development of these contractures, as taken in five cases previously reported, (9), have brought out the following facts:

1. The flexion of the wrist is either the primary factor or else follows quickly flexion of the fingers.

2. The extension in the metacarpophalangeal joints always follows, never precedes, the flexion of the wrist.

From the standpoint of muscle mechanics it is easy to understand why the hyperextension of the metacarpophalangeal joints is the later occurrence.

As the flexion of the wrist increases, the reserve power of the flexors become less and less, while that of the extensors constantly increases until there is a predominance of the extensors over the flexor muscles of the fingers.

With the wrist fixed in flexion the action of the extensors is directed toward hyperextension in the metacarpophalangeal joint. In this action the extensors are directly antagonistic to the interossei and especially the lumbricales. If these muscles are damaged, as is the case in severe forms of Volkmann's contracture, hyperextension will come about so much more rapidly.

In the treatment of this deformity, therefore, the release of the contraction of the wrist was considered to be of first importance and the treatment started accordingly. It was begun with the operative release of the contraction of the wrist by means of plastic lengthening of the flexor tendons. The after-

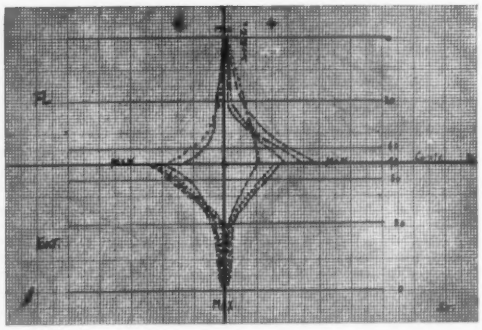

Chart 3. Cosine curve. Showing stabilizing power of the muscles of the hand; note maximum at o degrees.

treatment consisted in the application of a hyperextension splint and in daily massage and muscle training, followed by systematic muscle education. Figures 1 and 2 show the result in one of the cases.

SPASTIC AND PARALYTIC WRIST DROP

Many students of this and kindred problems, but by no means all of them, have recognized the drop hand feature as the keynote to the functional disability of the hand in cases of central as well as peripheral spastic or paralytic conditions. Consequently numerous operative methods were employed to produce hyperextension. The majority of orthopedists prefer tendon transplantation, Speed (10), Murphy (11), Axhausen (12), Gessner (13), Fischer (14), Spitzy (15); some prefer arthrodesis (Goudier, 16); and others arthrodesis combined with tendon transplantation (Lange, 17). Cole (18), used the silk ligament method.

Many types of hyperextension splints have also been described to be used before or after operation, (Gassette, 19), Erlacher (20), Langemak (21), Tuffier (22).

In the cases of wrist-drop reported here an attempt has likewise been made to establish first of all the principle of hyperextension of the wrist. The transplantation of the flexors of the wrist directly upon the extensors of the fingers, as practised by some, seems mechanically irrational. Unless the hand can be given the extension position first I cannot see how the extension movement of the fingers, even if such transplantation should prove successful, would materially aid in bringing about the functional use of the hand. On the other hand, extension or hyperextension of the wrist alone will materially improve the grip for the reason explained in the foregoing.

Case 1. L. Mc., age 11, admitted April 12, 1917. Spastic hemiplegia of the left side; spastic equinus was corrected by tenotomy; left hand in position of spastic flexion contraction.

This condition was treated by tenotomy and plastic lengthening of the flexor tendons. This corrected the flexion contraction so that the hand could be carried passively into hyperextension without resistance. A hyperextension splint was applied. Several months later permanent extension position of the hand was secured by the following procedure:

A dorsal incision was made over the radius, and the extensor carpi radalis longior and brevior and extensor digitorum communis were carefully dissected. These tendons were pulled upward under strong tension and united to each other. The union between these tendons proximally from the septum dividing the two compartments of the annular ligament, prevented a sliding forward of the tendons. This, however, was not sufficient to maintain the wrist in hyperextension and an arthrodesis of the wrist was therefore added four weeks later. The hand is now held in hyperextension and does not drop. By a certain mechanism consisting in flexion and extension at the elbow, the patient is able to contract and relax the flexors of the fingers and, in this way, to pick up light objects from the floor (Figs. 3, 4, and 4a).

Case 2. L. M., age 12, admitted July 12, 1917. Spastic drop hand from polio-encephalitis.

Flexion contraction of the right wrist and hyperextension of the metacarpophalangeal joint was corrected by plastic lengthening of the flexor tendons of the hand. Following the operation the hand was placed in a hyperextension splint and exercises were instituted. Three months later the function of the hand was as follows:

Flexion could be carried out in the metacarpophalangeal joint and in the end phalanges. The midphalangeal joints, however, are still extended. This case is an example of the peculiar disturbances of the equilibrium brought about by the action of the interossei and the lumbricales. While co-workers in the flexion of the metacarpophalangeal joints these muscles are entirely antagonistic to the superficial flexors of the fingers in regard to the midphalangeal joint. Normally they act as a check to the superficial flexor so that the flexion of the midphalangeal joint by this latter muscle may be properly graduated. In this instance the flexor sublimis was considerably weakened and therefore could not display any action at all against the lumbricales with the result that the hyperextension in the midphalangeal joint was produced by the latter muscles.

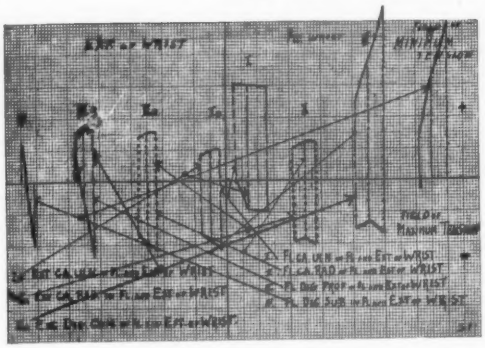

Chart 4. Shows numerical values of contraction power in flexion and extension of the wrist. Compare the values of contraction of the flexor muscles in either flexion or extension of the wrist. Contraction in flexion of the wrist occurs in the field of minimum tension, while the same amount of contraction of the fingers with extension of the wrist occurs in the field of maximum tension. Compare diagram 4 and 4a on the extremes of the sides of the picture.

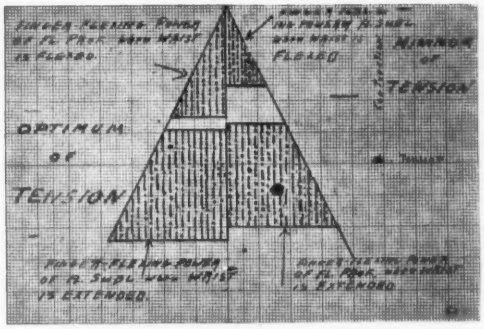

Chart 5. Shows relative amount of muscle power in either optimum of tension or minimum of tension. Values of ordinata are arbitrary and therefore the different figures only have relative value. The large trapezoids represent muscle power displayed in optimum tension and the smaller triangles, in the minimum tension.

But as the after-treatment proceeded and the sublimis became stronger, it was able to carry out flexion in the midphalangeal joint against the action of the lumbricales, although still with great effort only.

As soon as this muscle regains sufficient power the hand is to be secured in extension of the wrist by operation.

CASE 3. V. M. Infantile paralysis. Admitted July 31, 1916. Complete paralysis of the left shoulder and elbow. Partial paralysis of the hand, the flexor muscles showing good function except the muscles of the thenar. There is flexion contraction of the muscles of the wrist and consequently no grip.

Two operations of tendon transplantation of the flexors of the wrist to the common extensors of the fingers failed.

One year later, in October, 1917, the case was again taken up and in this instance extension of the wrist was obtained by embedding the extensor carpi radalis longior and brevior into a groove made in the dorsal surface of the radius, proximal to the anular ligament. Had this been followed by side-to-side attachment of the extensor carpi tendons and the common extensors of the fingers, or by arthrodesis, the result might have been still better. As it was, however, the patient improved to the extent that two months later she could open and close the hand and hold light objects (Figs. 7 and 8.)

FLEXION CONTRACTION FOLLOWING ACUTE INFLAMMATORY CONDITIONS

CASE 4. B. C., age 17, admitted September 27, 1917. Ankylosis of the wrist following an acute infection, probably osteomyelitis, 6 months ago.

The deformity developed gradually forcing the hand in extreme flexion and ankylosing in this position. There is no hyperextension in the metacarpophalangeal joint. There is no flexion of the fingers. The contracture of the wrist affected solely the wrist-joint and characterizes the case as an extramuscular lesion.

The operation consisted in a wedge-shape resection of the carpus, the bones of which were so fused that no distinction could be made between the different carpal bones. After removal of wedge ankylosis in extension was obtained. Photographs (Figs. 9 and 10) show the considerable amount of improvement in the function of the hand which was derived merely from correction of the flexion deformity. The patient gradually gained considerable use of the hand and can do almost any kind of work, although there is no motion in the wrist.

CASE 5. F. A., age 25, admitted July 27, 1917. Traumatic myositis and synovitis. The patient was caught under a roller and her forearm was severely lacerated. Severe infection followed involving both the tendons of the flexors and extensors of the wrist. On examination the motion of the elbow is found to be free except that extension is arrested at 150 degrees due to scar contractures at the elbow. The wrist is held in flexion of 120 degrees with the metacarpophalangeal joints in strong hyperextension and the phalangeal joints in flexion. The development of the contracture was as follows:

First, flexion contraction of the wrist, then increased flexion contraction of the fingers and lastly hyperextension in the metacarpophalangeal joints.

Operative procedure was first carried out for the relief of flexion contraction of the wrist and consisted in plasty of the flexors. A hyperextension splint was then applied and persistent after-treatment instituted especially to correct the hyperextension in the metacarpophalangeal joints. The

after-treatment, however, failed to accomplish anything in the way of releasing the extremely resistant hyperextension contraction.

For this reason the extensor communis and that of the fifth finger were lengthened operatively, four months later, by dorsal incision proximally to the anular ligament. This produced results in releasing the hyperextension by about 30 degrees for the fifth and second joints, less for the fourth and none for the third, but did not entirely correct the hyperextension.

A third operation was done four weeks after the second as follows: a curved incision was made over the dorsum of the hand making a flap with proximal base. The extensor tendons were found to be transformed in an irregular network of scar tissue, having entirely lost their identity. After extensive incisions and resection of the scar tissue, the hyperextension deformity could be completely overcome in all metacarpophalangeal joints, except the third, and flexion in this joint of about 30 degrees was obtained.

This enabled the patient to approach almost completely the fingers to the thumb after a period of two or three weeks. Under after-treatment the use of the hand is constantly improving (Figs. 11 and 12).

RECONSTRUCTION OF THE MOTION OF THE THUMB

The great importance of the thumb for the gripping motion of the hand has always been recognized and a great number of operative procedures are described with the object of either substituting the missing or mutilated thumb, or to improve its function. In regard to the methods of substitution I shall merely mention the work of Nicoladoni (23), Schepelman (24), Kraft (25), Mayer (26), Horhammer (27), Hanley (28), Muriel (29), and others. The methods of autoplastic substitution do not come within the scope of this paper. The cases reported concern methods of tendon transplantation and plastics only.

Biesalski and Mayer (30), in their splendid work on tendon transplantation describe one method which has been partially used in one of these cases.

CASE 6. V. P., age 6, admitted July 17, 1917. Polio-encephalitis with hemiplegia of the right side. The spastic equinus condition of the right limb was corrected by tenotomy. The condition of the hand is as follows: Flexion and extension can be carried out without great difficulty. Closing and opening of the fingers can also be accomplished although with a certain halt. But when closing the hand, the thumb is always thrown under the fingers so that no grip is possible. This is due to the overpowering action of the flexors of the thumb. For the relief of this disturbance of equilibrium between the flexors and extensors of the thumb an operation is made similar to the one described by Biesalski.

Incision is made on the dorsum of the hand over the metacarpal of the index finger and the tendon of the extensor indicis is dissected and split from the metacarpophalangeal junction upward. A second incision is made over the extensor pollicis longus. The severed half of the extensor indicis tendon is drawn through a tunnel and is fastened to the tendon of the extensor pollicis so as to act as a check to the flexion of the thumb. The tendon sheaths are then closed and the wound sutured.

By this mechanism the thumb is given a springy resistance against flexion. After the operation the following condition was noted:

Whenever closing the fingers the wrist was placed in hyperextension for this purpose. Then the tendon common for the index finger and the thumb acted as follows:

It extended the index finger getting it out of the way of the thumb, and then in closing the fingers together the thumb was checked just enough so that it would not be thrown underneath the fingers but would meet with the tip of the middle finger of the hand above which the index finger closes in at the same time. In this way the function of the hand was improved very considerably so that the patient was able to do handwork of different kinds (Figs. 13, 14, 14a).

The following two cases represent instances in which opposition of the thumb was lacking due to peripheral lesions of the ulnar and median nerves. The last case was one of the cases of Volkmann's contracture.

CASE 7. F. B., age 12, admitted June 12, 1917. Paralysis of the ulnaris occurred 9 years previous following an accident to the elbow. Examination of the hand shows good action of the long flexors of the hand and wrist with the exception of the flexor carpi ulnaris. The thenar muscles are very atrophic, especially the interossei and lumbricales which are paralyzed. The paralysis extends mainly into the sphere of the ulnar nerve but there is also some involvement of the short muscles of the thenar supplied by the median nerve. The thumb is held laterally to the side of the second metacarpal with hyperextension of the metacarpophalangeal joint. In all flexion movements of the fingers, the thumb fails to participate on account of its entire lack of opposition. The condition is remedied as follows:

Incision is made from the interphalangeal joint upward to the middle of the thenar directly over the long flexor of the thumb. This tendon is dissected out after its sheath is opened. The tendon is then split lengthwise and the radial half of it inserted periosteally to the radial side of the base of the proximal phalanx of the thumb. Closure of the tendon sheath and suturing of the wound.

By this procedure the long flexor of the thumb is

given a double insertion: the normal one at the base of the end phalanx and a new one at the outer side of the base of the proximal phalanx. In this way, not only flexion of the end phalanx is preserved but the thumb is also forced to swing over toward the palm of the hand in opposition to fingers.

One month after operation the function had improved very satisfactorily. The patient was subjected to persistent after-treatment of massage and muscle education. She was very soon able actively to touch the thumb and the tips of all the fingers as shown in attached photographs (Figs. 15, 16 and 16a).

CASE 8. L. D., age 9, admitted May 17, 1917. Volkmann's contracture, following a fracture of the elbow three months previously.

This case has been described in the former series of Volkmann's contracture (9). It is mentioned here because of the fact, that in this case, also, opposition of the thumb was entirely lacking as the muscles of the thenar and the interossei were paralyzed. After the contraction had been corrected by operation and after-treatment, the insufficiency of the thumb action was corrected by operation six months later.

The technique used was practically the same as for the operation used in Case 7.

The result of the operation was apparent as early as two weeks later, when, as the photographs show, the thumb could be opposed to the fourth and fifth fingers (Figs. 17 and 18).

In all cases mentioned the after-treatment was directed first along the lines of massage and active and passive motion with the same principles and precautions as are used in tendon transplantation methods for the lower extremities. The patients are required to wear the splints day and night and they are only removed for and during the time of treatment. Following this mechanical treatment a great deal of stress is laid upon muscle education. This is carried out under the supervision of a trained teacher, who is sufficiently instructed to understand the underlying pathological conditions. The children are made to use their hands according to the individual case with special consideration to those muscles which are in need of re-education. Most of the patients start their work with clay molding in the most elementary form. They then proceed to the more complicated functions; as reed work, raffia work, drawing, weaving, and so forth.

I have found that most of them make very creditable progress beyond the stage in which they are left at the conclusion of the medico-mechanical treatment. It is necessary to carry out the work of muscle education entirely systematically and in such fashion that the individual requirements of the case is made the determining factor for all details of the work. Two points are essential:

1. Absolute individual instruction.
2. Constant medical supervision of the work of muscle re-education.

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A NEW OPERATION FOR PROLAPSE OF THE UTERUS[1]

By CLIFFORD U. COLLINS, M.D., Peoria, Illinois

THE operation that I present is designed for cases of complete prolapse where the uterine ligaments have lost their elasticity as evidenced by the uterus remaining permanently outside of the body and not receding when the patient is lying down. Kocher's operation, or Murphy's modification, is usually done in this class of cases.

If there is a cystocele so pronounced that it is not reduced when the uterus and cervix are pushed back high up in the pelvis, my operation had better be preceded by an anterior colporrhaphy that restores the anterior pelvic floor.

The patients who have the indication for this operation, are usually patients well along in years, who have had the accompanying derangement of bladder function for a long time. For these reasons they are handicapped patients and are not good surgical risks. They should be under observation for some time previous to the operation so they may be put in as good condition as possible. As the patient has not been able, probably, to completely empty the bladder for a long time there has necessarily been a back pressure on the kidneys. After the operation the patient will be able to drain the bladder at each urination and the back pressure will be suddenly relieved. In order to know how the patient's kidneys will stand the sudden relief of this back pressure, it is wise to hold the uterus high up in the pelvis with a gauze tampon, and to place a Pezzer catheter permanently in the bladder, for some days preceding the operation. If the patient fails to stand well the continued drainage with relief of the back pressure, the tampon and catheter can be removed, and the patient kept under observation and treatment a while longer when the test can again be made. This test is similar to that suggested by Judd in cases of hypertrophy of the prostate gland. In failure to empty the bladder these prolapse cases are analogous to prostate gland cases.

Care should be taken that all preliminary details are completed before the anæsthesia is begun so that there will be no delay during the operation, which should be completed as rapidly as possible.

A transverse Pfannenstiel incision is made over the pelvis. After the transverse incision is made through the aponeurosis, or anterior wall of the sheath of the recti muscles, another transverse incision is made about two and one-half inches long, paralleling the first incision and one-fourth inch above it (Fig. 1). The strip of aponeurosis thus formed has its

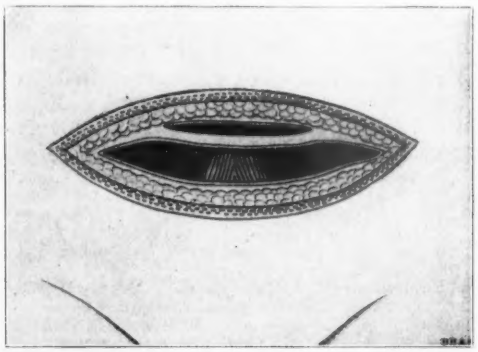

Fig. 1. The strip of aponeurosis is made by the parallel incision just above the first incision.

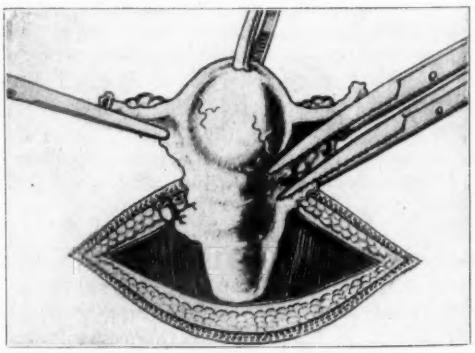

Fig. 2. In doing the supravaginal hysterectomy the structures are usually atrophied and the broad ligaments can usually be ligated en masse.

[1] Read before the Western Surgical Association, Omaha, December, 1917; and the Chicago Surgical Society, March 1. 1918. (For discussion see page 351.)

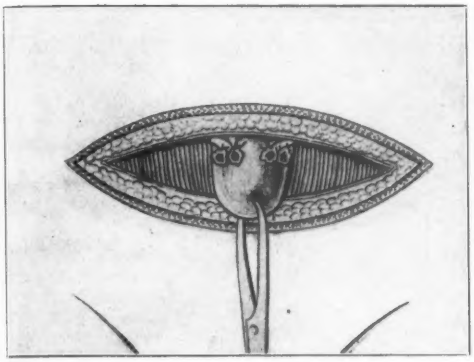

Fig. 3. The cervix is held forward while the broad ligament stumps are sutured to its posterior surface and to each other.

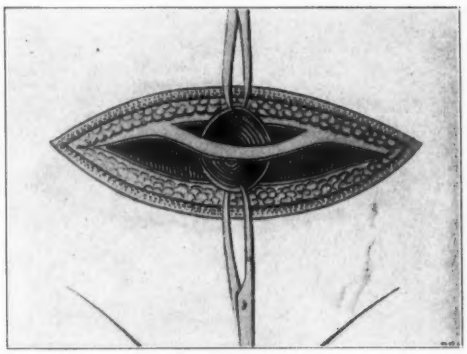

Fig. 4. The cervical flaps are held apart and the strip of aponeurosis is laid in the trough thus formed.

natural attachment at each end and is composed of tissue that does not stretch. The recti muscles are separated and the peritoneum incised longitudinally.

A supravaginal hysterectomy is done (Fig. 2), removing a V-shaped piece out of the cervix, thus leaving an anterior and posterior flap on the cervix. The broad ligaments can usually be ligated *en masse*, because these patients are generally elderly and there is more or less atrophy of the pelvic structures. While the two cervical flaps are held forward the stumps of the broad ligaments are sutured to the posterior surface of the cervix and to each other (Fig. 3).

The cervical flaps are then held apart and the strip of aponeurosis is dropped in the cervical trough thus formed (Fig. 4). The flaps are then sutured together over the strip (Fig. 5). The edges of the peritoneum and the recti muscles are sutured together around the cervix. The edges of the aponeurosis are sutured over the cervix leaving the strip dipping down into the cervix (Fig. 6). With the suturing of the fatty layer and skin the operation is completed.

The cervix is thus held securely in the abdominal wall by a strip of aponeurosis that will not stretch and cannot come loose from its attachments, because they are natural and have not been separated. The cervical tissue usually is hard and dense and when the two cervical flaps have united firmly over the strips, it is not likely to give way.

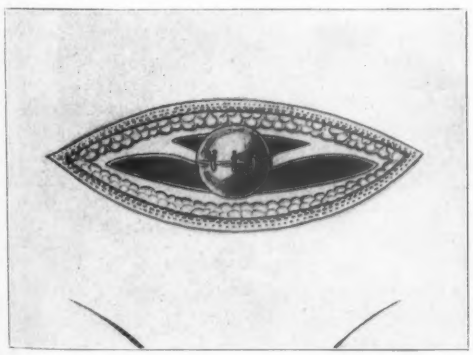

Fig. 5. The cervical flaps are sutured together over the strip of aponeurosis.

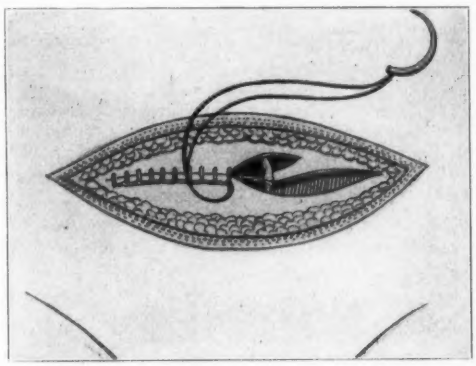

Fig. 6. The edges of the aponeurosis are sutured over the cervical stump and the supporting strip.

It seems to me that this operation is superior to Kocher's operation in that no comparatively large pieces of uterine tissue are left in the abdominal wall between the aponeurotic and muscular layers. The suspending power of Kocher's operation depends on the union of dissimilar structures — uterine tissue with muscle and aponeurosis; while the strength of this operation depends on a normally attached strip of aponeurosis, and the union of similar dense structures (the anterior and posterior cervical flaps) over this strip.

In doing this operation I have found that the cervical canal is frequently a source of infection unless steps are taken to prevent it. I have tried tincture of iodine, carbolic acid followed by alcohol, and the Percy cautery in the cervical canal, and the carbolic acid and alcohol seems to give the best results.

THE PRACTICAL VALUE OF ELECTRIC LIGHT IN THE TREATMENT OF INFECTIONS[1]

By A. J. OCHSNER, M.D., LL.D., F.A.C.S., Chicago
Surgeon-in-Chief, Augustana Hospital and St. Mary's of Nazareth Hospital; Professor of Surgery, University of Illinois, College of Medicine

THE object of this paper is to direct the attention of surgeons to the great value of electric light rays, especially because of their influence in controlling pain due to infection.

The rays of the sun have been used for many years, and various special light rays have been employed to a great extent, especially in sanitarium practice, usually by enthusiasts in whose judgment neither the general practitioner nor the surgeon has had reason to place great confidence. As a result of this circumstance, one has had the feeling that any apparent benefit probably came from the element of suggestion contained in the treatment. Most of the patients treated in these institutions are neurotics who require and demand some fad, and whether the light is red or blue or ultraviolet, the result is the same.

On the other hand, the treatment of infections by means of heat is as old as medical history. There is a certain degree of heat connected with all light treatment; consequently, whatever benefit was not attributed to suggestion could easily be attributed to the heat accompanying the light.

It is a well-known fact that there is a marked physical difference in the wave lengths of different light rays, and a difference in the length of waves caused by the heat obtained from heated objects and those obtained from light, and there is a corresponding difference in the depth to which these rays penetrate.

One could write a book on the differences existing between these rays and build up fine theories upon the effects of these differences, but my object is to set forth clinical observations and to leave the physics of the subject to others.

Four years ago, when I suffered from a violent infection of my elbow, it became necessary to expose the ulnar nerve when the abscess was laid open. This gave rise to intense neuralgic pains which continued for many days without cessation, notwithstanding the use of wet and dry heat.

At the suggestion of Dr. Saurenhaus, I applied an electric light apparatus similar to the one shown in the accompanying figure. Within an hour the pain disappeared, not to return.

My natural skepticism regarding the effect of therapeutic measures led me to think this might be due to coincidence, and that possibly the pain might have subsided at this time had we not employed the electric light.

During the past four years, however, I have had an opportunity to test this method at the Augustana Hospital in 78 similar cases of infection of the extremities, and invariably the pain has disappeared promptly. Sixty-one

[1] Read before the Chicago Surgical Society, March 1, 1918. (For discussion see p. 350.)

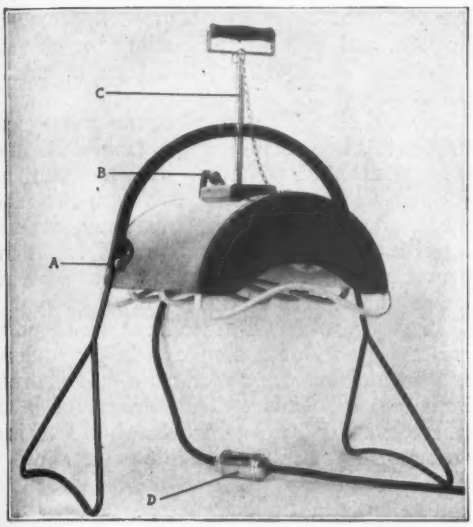

Fig. 1. Adjustable electric therapeutic light. *A*, Lock on folding stand; *B*, adjustable reflector; *C*, rod for elevating and lowering reflector; *D*, button for regulating number of lights used.

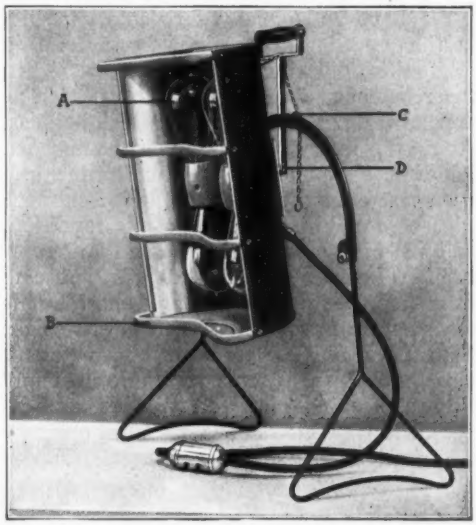

Fig. 2. Reflector adjusted for treatment of side of patient.

of these cases were infections of the upper extremity, and 17 of the foot.

In order to illustrate the type of cases in which the use of electric light is especially valuable, I will quote the history of an illustrative case now under my care at the Augustana Hospital.

Mrs. L. P., age 64, Case No. 53451, admitted February 7, 1918. Family and past history unimportant.

Present complaint. Eight weeks ago the patient's little finger became infected. It grew red and became swollen, the swelling involving the entire hand and forearm. The third finger was markedly involved. During the past seven weeks the little finger, the third finger, the palmar and dorsal surfaces of the hand were lanced seven times, four times producing pus, and three times serum. There has been much pain in hand and arm during the entire time. Some slight soreness was noticed on third day of infection in the axilla. The treatment has consisted in free incision of areas suspected of containing pus, and thorough drainage by means of iodoform wicks, and the application of large moist boric acid dressings.

Immediately after admission the patient was placed in bed, a large moist dressing was applied and covered with rubber cloth, the forearm and hand were placed on a splint, and the electric light was applied. A small amount of fresh, hot boric acid solution was poured into the dressing every three hours, sufficient to keep it wet. The electric light was kept in action night and day. The dressings were changed every forty-eight hours.

Within an hour after the application of the electric light this patient was free from pain, and she has remained free. Within twenty-four hours after beginning this treatment the facial expression of the patient has changed from that of a discouraged, severely ill person subjected to extreme suffering, to one free from pain, contented and hopeful. The wounds improved rapidly. Within the first week the sloughing tendons could be removed without pain.

In the meantime we continued the use of large moist dressings covered with rubber cloth, adding a small amount of the fluid every three hours to keep the dressings moist. The hand and forearm were immobilized by means of a splint placed underneath the forearm and hand, and the hand was carefully supported during the change of dressings. All unnecessary pressure and manipulations were avoided. The gauze drains which were present when she entered the hospital were removed at the second dressing and no new drains were inserted. The bone of the second phalanx of the third finger was removed at the second dressing, as it was perfectly loose in its place.

Our experience has been practically the same in all of our cases of this class, and neither we nor our patients would be willing to get on without the use of light in these cases.

We have had equally satisfactory results in the use of the electric light in treating peritonitis following abdominal sections for the relief of suppurating conditions such as appendiceal abscesses, perforated gall-bladder, etc., also in tuberculous and gonorrhœal joint infections, in carbuncles and furuncles.

In case of X-ray burns the light treatment causes a rapid improvement of the condition, and one of my assistants who had an opportunity of treating many patients suffering from frozen extremities, assured me that his results were much better with electric light than with any other form of treatment. George W. Crile reported that in many French hospitals infected wounds are exposed to the continuous rays of ordinary electric light bulbs. He was impressed with the fact that there was a marked decrease in pain, and that wound healing progressed very satisfactorily under this form of treatment.

I would strongly urge all of my colleagues to give this treatment a careful trial, and I am confident that all will adopt it. I believe that the general introduction of this form of treatment of septic wounds, especially of extremities, in army hospitals would result in great reduction of suffering, as well as a rapid improvement in the condition of the wounds.

The apparatus which we have found most useful consists of a simple reflector underneath which one or two ordinary electric light bulbs are suspended. The amount of heat can be varied by changing the bulbs to increase or decrease their candle power.

DEPARTMENT OF TECHNIQUE

BONE-GRAFT AND ARTHRODESIS IN RECONSTRUCTION SURGERY[1]

By F. G. DUBOSE, M.D., F.A.C.S., Selma, Alabama.

THE war has given an impetus to reconstruction surgery. It has been suggested by the Army Medical Department that civil surgeons begin to "round up" the crippled and deformed in and among their clientele, and to advise that such surgery be done on them as will tend to place them in a functionally more useful condition.

This is a "preparedness propaganda," conserving the resources of the state in increasing the efficiency of every deformed individual, and fitting the surgeon to meet a probable demand for restoration to function of those maimed in the fight for universal freedom. No greater source of enthusiasm than one's patriotic desire to do his part is needed to meet this demand among those of us whom circumstance has kept at home, and it is hoped it will so perfect our skill and technique that we will not fail.

Orthopedic surgery affords a fertile field for useful work. This branch has not been attractive to the majority of surgeons for reasons which arise from two different points of view held by patient and surgeon; the former expects an absolute anatomical, functional, and cosmetic restoration with an immediate return to normal appearance and usefulness, the latter hopes primarily to re-establish functional usefulness, and along with it such anatomic and cosmetic results as are compatible with the maximum degree of serviceability, and is satisfied with ultimate and partial restitution. The result is a dissatisfied though benefited patient, and a doctor chagrined with disappointment. The psychology of enthusiastic endeavor depends on more than the factor of self-satisfaction; the pleased patient is no small incentive in this matter. It is an essential safeguard that a none too optimistic outcome is pictured to the patient; better obtain benefiting results beyond the promise than to fall below an assured expectation.

There is a tediousness, or time-taking element, in reconstruction surgery greater than in ordinary operations; particularly is the contrast noticeable when compared with abdominal surgery, especially that done for acute conditions both in operation and subsequent course of after-treatment. There is a pain habit existing as truly as the status epilepticus, and painful distortions endured over many years require a long interval of time after operative relief before the pain impulse is obliterated, which is as discouraging to the patient as it is irritating to the surgeon.

It is not my purpose to demonstrate any new technique, but to emphasize some of the fundamental factors making for success with reference to apparatus and appliances, as well as certain precautions apparently or evidently essential before, during, and after operating, and to make a plea for early operation in destructive joint disease, in metastatic osteo-arthritis, doing radical arthrodesis before extensive destruction of joint structures or bony framework has occurred. In the light of more extended experience, it may be predicted that delay in operating on infected joints of certain selected types may soon become as reprehensible as that of delay in operating for osteomyelitis.

Preliminary preparation of the patient in building up resistance with vaccines, protecting with sera, elimination of intestinal toxines, alkalinizing the system, loading it with carbohydrates in the form of glucose, and filling the tissues with fluids before and in prolonged operations by hypodermoclysis during the operation, are all well understood, in fact commonplace, yet need constant em-

[1] Read before the Southern Surgical Association, St. Augustine, December, 1917

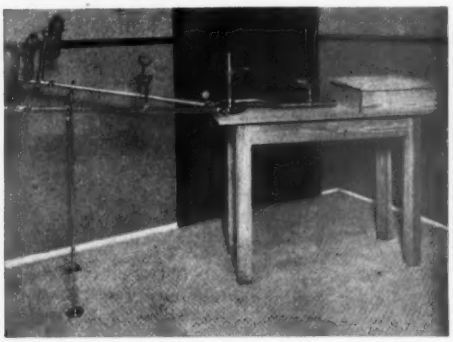

Fig. 1. Orthopedic table, Echol's traction, fixation apparatus assembled.

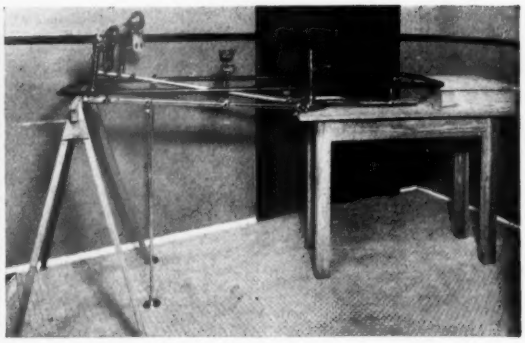

Fig. 2. Orthopedic table with Bradford frame.

phasis not only because they are elements of success in the desperate cases, but they also add a world of postoperative comfort in every case, when judiciously employed.

The equipment essential for the best results in arthrodesis and bonegraft surgery, unless the surgeon has a mechanical turn or talent, must be extensive as well as expensive. I shall demonstrate by models and photographs a practical working basis in equipment, which is both inexpensive and efficient. The table here shown, when to it is added the portable attachment, will at a small cost do all that the more elaborate and expensive tables will do. This modified Bradford frame is really a product of the University of Pennsylvania Hospital simplified. The frame can be made in any plumbing shop. It has the splendid advantage of permitting the patient to be moved in bed for bathing, and for defæcation, without pain or disturbing in any way traction, extension, or position, of the parts, and of retaining the parts in exact apposition during any desired changing of patient, who can be moved out on to a porch or into a sun parlor with ease, as the frame and patient are all one piece. Among other advantages the frame and canvas can be placed over either the orthopedic or operating table, and the adjustments made during or on completion of the operation, fixed and retained before the patient is moved. In some instances this is an important factor, particularly in arthrodesis and in certain fractures with insecure fixation by bonegraft.

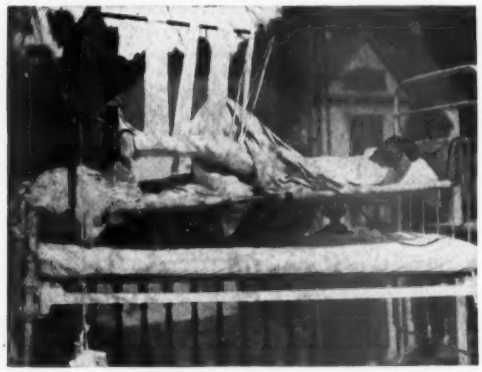

Fig. 3. Photograph showing patient in fixation frame on bed.

A simple extension apparatus is made by inserting sash pulleys into a pine board; for extension the board is placed at the foot of the bed and secured by cords. For an overhead trolley a long piece of timber, two by two, with screw pulleys at intervals is supported over the bed on four pieces, two at foot and two at head of bed. Various wire, angle iron, tubular frames, or splints can be made at any blacksmith shop to suit the case in hand. These are real tailor made splints, and are vastly superior to the stock pieces advertised or sold by instrument houses; particularly is this true of the Thomas and other wire splints in general war use. Add to this plaster-of-Paris bandages with a few straps and buckles, and a definite knowledge

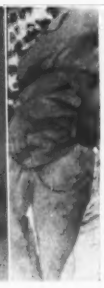

Fig. 4. Fig. 5. Fig. 6.

Fig. 4. Case 1. Osteo-arthritis. Complete destruction of the head and neck of the femur. Displacement of the upper end of the femur. Osteomyelitis of the upper third of the shaft.

Fig. 5. Case 1 after operation.

Fig. 6. Case 1. Photograph of hip after recovery.

Fig. 7 (at left). Roentgenogram showing complete bony ankylosis between acetabulum and femur.

Fig. 8. Roentgenogram showing results of arthrodesis.

of what one wishes to accomplish, and the armamentarium for a working basis is complete.

Technically, the joint, bone, and tendon operations are not more difficult, but the successful outcome is more largely dependent on absolute asepsis, and the chances are relatively far greater for failure following a careless or indifferent aseptic technique in this class of surgery than in any other. Infection not only spells failure, but frequently is lifetaking. It almost certainly deprives the patient of future opportunity for a second successful trial. This is the real domain of knife and fork surgery.

Antiseptic treatment is a pre-operative measure, while aseptic technique is paramount and must be actuated by mental alertness with a regard for strict cleanliness approaching fanaticism. With the hands trained to avoid touching the open wound, the operator must forego in this class of work that wealth of information gathered by the educated touch in exploring deep and unseen recesses, as is so valuable in abdominal operations. Experience in time will soon give the same impulses, though diminished in fineness of perception, through the grasp of the handle of the knife, chisel, gouge, or elevator. Incised margins of skin should be protected, and no skin left exposed after incision. Every instrument should be regarded as unfit for further use once it is removed from the wound, until it has been boiled. Each gauze mop should be discarded from its metal holder as soon as it has wiped the wound one time only. The gloved hands should be regarded as a menace if they touch not only the wound, but also the part of the instrument which will touch the tissues. The thread and needles should be handled with instruments only. Every knot can be so securely tied with hæmostats as with the fingers and almost as quickly. Hæmostats should be used invariably for this purpose

Fig. 9. Fig. 10. Fig. 11.

Fig. 9. Case 3. Metastatic osteo-arthritis of the hip-joint, showing acetabular disease with bulging of its walls into the peritoneal cavity.

Fig. 10. Roentgenogram showing the results of arthrodesis in Case 3.

Fig. 11. Photograph of the back in Case 3, showing recovery. Case 4.

Fig. 12 (at left). Bony ankylosis of the knee in epiphyseal fracture of the femur.
Fig. 13. Roentgenogram of Case 4 taken after operation.

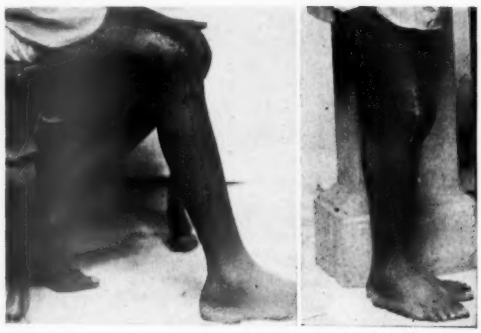

Fig. 14 (at left). Photograph of Case 4 showing the patient sitting after arthrodesis of the knee.
Fig. 15. Case 4 standing.

instead of the fingers. Not only the surgeon must be trained aseptically as to conscience and hand, but his assistants must be equally so.

The work of Carrel-Dakin and associates, if carried out in systematic detail, is beyond question time and tissue saving. It permits clean work to be done in recently septic wounds within a few weeks after instituting the treatment, the microscopic findings of not more than one organism to three fields being the guide in instituting final surgical effort, and a closed operation in an open, discharging, though clean wound. The 2 per cent formalin glycerin injection of septic joints after the method of the late J. B. Murphy, previous to arthroditic operations, is correspondingly efficient in this class of surgery.

In the Vaughan Memorial Clinic, the above preliminary treatment in cases of types indicated has been so satisfactory that I have found no occasion to try out "b. i. p." or the analine dye pastes; the latter, however, because of staining necrotic tissue in addition to microbicidal properties have a distinct field of usefulness in recently septic wounds, particularly in bacillus capsulatus aerogenes infections, where the removal of all dead tissue is requisite to eliminate spreading cultures of this organism, while free and liberal incisions permit drainage. The removal of all focal infection preliminary to bone, joint, and tendon operations is a safeguard against wound infection that should never be overlooked and neglected. Wherever and whenever time permits, teeth, tonsils, accessory sinuses, and all possible sources of focal infections are removed prior to operation; otherwise these are attended to at the same time the other surgery is done.

Specialism has the disadvantage of one-sidedness, exaggerating one's estimate of reflex influences, or of the relationship of that specialty to the general morbidity existing in the patient under treatment, with the result that all disorders of the system are attributed by the specialist to the pathology under treatment by him. Getting into this groove is rather difficult to avoid, because we very frequently observe distant and apparently dissociated pains and disabilities disappear after removing some remote disease or deformity. Thus arise fads in medicine, making fashionable appendectomies, removal of teeth, tonsils, gall-bladders, and such organs as are not essential to life, under the suspicion that they are harboring focal infections, causing reflex nervous or digestive disturbances.

Not to be distanced orthosis in surgery is beginning to include in its special line of work in addition to the gross deformities, the obscure deviations and the general morbidity possibly resulting thereform.

Persistent efforts over long periods of time, with a remuneration far less proportionately

for time and effort expended than in almost any other department of surgical endeavor is to be anticipated. Final results that are worthy of best efforts follow efficiency raised to the highest degree.

Reconstruction operations are the consummation of conservative surgery. All is saved that can be used, and all is used that can be saved.

The first three cases in this report are of metastatic osteo-arthritis, representing varying degrees of destruction of the hip-joint as time lengthened and disease extended. The methods employed in each, results obtained, and conclusions deducted thereform are given.

CASE 1. Mrs. C., white, age 36, married. History of injury to left hip when two years old. At eleven the patient fell and fractured her left leg above the knee. She was in bed for weeks following this injury. She suffered with recurring attacks of pain in the hip. The left leg became shorter. She was thrown from a buggy in 1914, and the left hip was injured. She was operated upon for appendicitis while still suffering from hip. The hip was not treated after injury. The abscess pointed and drained on the inner side of the thigh near the crotch, the septic condition continued and was accompanied with recurring chills. The patient entered the Vaughan Memorial Hospital, October 15, 1916. There was a sinus which discharged on the inner side of thigh, fluctuation was present under the reddened area on the outer aspect of the thigh. The pus was evacuated and a tube inserted into each opening. Culture showed colon bacilli predominating. The Carrel-Dakin treatment was begun, and three weeks later the discharge contained not more than one micro-organism to three fields. The X-ray showed the trochanter riding three inches above the acetabulum. The head and neck of femur were completely absorbed. The upper third of the femur was diseased. Operation was performed December 18, 1916. Exposure of joint was made through the Murphy goblet incision. The acetabulum and all diseased bone were curetted. The upper third of the shaft of the femur was tunneled. The large pyogenic sac surrounding the joint was curetted. The aponeurosis of the contracted muscles was divided and the tendons lengthened, so that when firm traction was made with pulleys, the end of femur was brought on a line with the upper margin of the acetabulum. Lax structures around joint, were dissected free, including some underlying muscle tissue, and this flap was sutured in the upper third of the shaft of the femur, completely filling the hiatus made by the chisel and curette. The divided muscles were sutured with catgut, and the wound closed without drainage. Dressings and plaster cast were applied, using

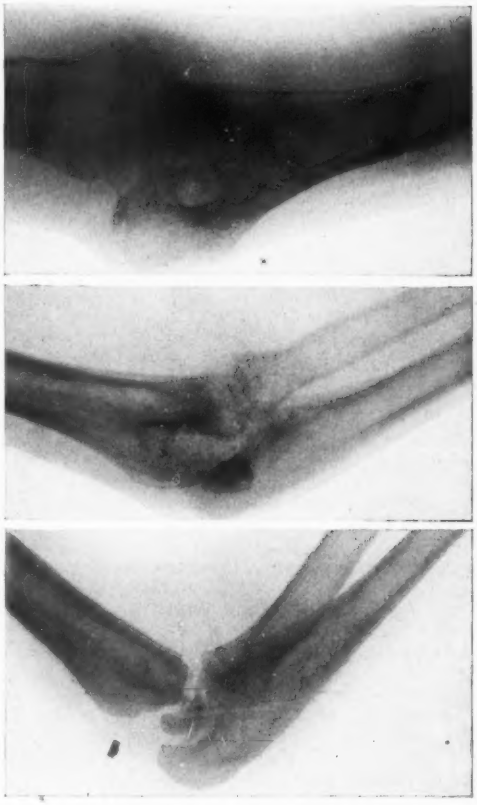

Fig. 16 (at top). Roentgenogram Case 5 showing anteroposterior view of fracture dislocation of the elbow-joint.

Fig. 17. Roentgenogram Case 5 showing lateral view of fracture dislocation of the elbow-joint.

Fig. 18. Roentgenogram Case 5 showing lateral view of elbow-joint after operation.

canvas and frame overlying orthopedic table. Extension straps of limb were transferred to the pulley of frame, thus securing the desired position without moving the patient. After operation the patient and frame, being all one piece, were removed from the operating room after all adjustments had been made. The wound healed without incident, and in three months the patient left the hospital, February 19, 1917, wearing a Thomas splint. She is walking with one crutch and has movable hip joint, with three inch shortening of limb. She is in splendid physical health. As time goes on she will be able to discard the crutch. The limp is being overcome by elevating the shoe on that side.

CASE 2. Mrs. P., widow, age 62, came to the Vaughan Memorial Hospital, May 22, 1917, to

Fig. 19 (at left). Photograph of Case 5 showing maximum degree of flexion of arm on forearm before operation.
Fig. 20. Photograph of Case 5 showing flexion after operation.

have a new brace made for the hip. The family history was negative. The patient had suffered from hip-joint disease since she was two years old, following an injury. There had been recurring exacerbations during 60 years. The general physical health had been good, except for these attacks necessitating confinement to bed with extension, then crutches, and braces. During the acute outbreaks the disability was complete, and pain agonizing. At the time of examination her temperature was 99.4°; pulse 80; blood count, leucocytes 12,000, red cells 4,000,000, and neutrophiles 76 per cent. The teeth were carious, pyorrhœa was present, and the gums receded. An X-ray of the right hip showed complete bony ankylosis, fusion of neck, head, and acetabulum into one bony mass. Typical adduction of deformity, and emaciation of thigh and leg. There was continuous pain in the hip, exaggerated by every movement. Arthrodesis was advised and the Murphy operation performed May 29, 1917. The margin of the acetabulum was entered by the chisel, and only the spongy neck of the femur remained, the head having been entirely destroyed in the osteitic process. The acetabulum was curetted and reamed out. The neck of the femur was shaped to fit. An aponeurotic flap was interposed and the operation completed step by step, as described by Murphy, using phosphor bronze wire instead of the nail in replacing the divided trochanter. Primary union was secured throughout, and the convalescence was in every way without incident, except for recurring attacks of pain which occurred without any explanation except that of pain habit. She was kept on the retentive frame with extension and counter extension, fixation of hips in double spica plaster bandage for three months. During the remaining three months in the hospital, she was on crutches and allowed to move the leg as in walking, with only the toe touching the floor. She can stand, sit, or lie down with comfort. She has adduction, abduction, flexion, and extension. The voluntary range of motion is limited by the extreme attenuation of all leg muscles from long disuse. The thigh muscles were thin and flabby, with considerable fatty degeneration. Her teeth were extracted at the time of operation. She has gained twenty pounds in weight, and is in better physical health than ever before. She was dismissed from the hospital December 14, 1917.

CASE 3. F. J. A., male, white, age 11, admitted to the Vaughan Memorial Hospital October 3, 1917, for hip-joint disease of four years' duration. In 1913 the patient was thrown while at play in school, falling on his left hip. He remained at school that day, but was unable to move the hip the following morning, and was in bed for two weeks suffering from a stiff and painful hip. He has been lame in the hip ever since, and has been confined to bed at intervals, though he is able to be up most of the time. After taking a horseback ride the last of September, he was compelled to take to his bed on October 3, 1917. He entered the hospital with a temperature 99.4°, pulse 84. His left hip was stiff, painful on pressure, and held rigid by tense muscles. The thigh was adducted, the leg flexed. Attempts at passive motion caused severe pain. The blood picture showed polymorphonuclear leucocytosis. The X-ray revealed acetabular disease with bulging of fossa. The teeth were good, the tonsils enlarged, but there was no history of sore throat. He was put to bed and extension applied. October 6 the temperature reached 102°. On the seventh day he was given mixed vaccine. October 8 his lowest temperature was 98.8°, highest 100°F.

This case is of unusual interest because it presented a doubt as to the best methods to pursue in its treatment. Here is an acetabulum filled with fluid, bulging its wall into the pelvis, eroded, and with a femoral head apparently uninjured; if it was injured in the beginning. The case is one seen during an acute exacerbation, with an attending rise of temperature and a leucocytosis. Under older conservative teaching, the case should have been placed in bed, extension and counterextension applied. Time would not only have caused the inflammatory process to subside, but no doubt would have resulted in a temporary cure; or the disease in its continued progress might have eroded and finally destroyed the elementary substance of the joint structure.

A résumé of Case 2 shows just such a condition which persisted for sixty years with recurrent exacerbations resulting in invalidism during the greater part of the time, and a cripple harnessed with hip splints during the remainder. It was diagnosed and treated as tubercular hip, and when finally presented for radical cure came with a complete bony fusion of the entire joint, with

Fig. 21. Case 6. Roentgenogram taken before operation. Osteitis cystica fibrosa. The plate reveals a bone cyst with marked curving of the upper end of the femur.

Fig. 22. Roentgenogram of Case 6 after operation. The cavities are almost filled with osseous material.

destruction of head of femur and consequently poor material with which to form a new and serviceable joint. Added to this the pain status was so firmly established that it is doubtful even with a perfect anatomic result if it will ever be abolished.

Therefore it was decided to do a radical operation, and obviate if possible long confinement to bed with only temporary benefit under the most favorable conditions, and avoid loss of the essential bony framework necessary in joint reconstruction. On October 9, 1917, arthrodesis was done, exposing the joint through a U skin incision. On opening the capsule a brownish fluid with flakes of coagulated fibrin was found filling the joint. After incision of the capsule, the head of femur was readily dislocated owing to destruction of its round ligament. All synovia were very red and swollen evidencing the acuteness of the inflammatory process. The acetabulum was deepened and conical in outline. All inflamed synovial surfaces were excised, the acetabulum curetted, reamed out, and swabbed with a 5 per cent tincture of iodine and dried. A flap of aponeurosis and fat was dried and stitched around the acetabular rim, and the head of the femur replaced. The usual steps were followed in completing the operation after Murphy's technique. The patient was placed on a frame with plaster bandage fixation and extension applied. Stock vaccine was continued at two day intervals for two weeks. The highest temperature the first day after operation was 100°, 102° for two days, 104° fourth and fifth days, 101° sixth and seventh days, steadily declining to normal during the second week. Following this there was no elevation of temperature. The patient was in bed for two months with no pain on movement. He walked on crutches. There were no limitations of voluntary movement as compared with the right hip. Complete restoration.

Case 4. Bony ankylosis from fracture of knee. T. J. , colored, age 17, was struck just above the knee by a piece of timber, in September, 1916. He was treated for fracture of the thigh. He was presented at the Burwell Infirmary, January, 1917, for stiff knee. He was unable to walk without crutches. There was bony ankylosis of the knee which was bent at an angle of seventy-five degrees. The X-ray showed a transverse fracture through the lower epiphysis of the femur, the upper fragment was displaced forward, impinging against the patella. There was a large callus extending posteriorly two and a half inches upward along the femoral shaft. Operation January 29, 1917. Following the technique of J. B. Murphy, the joint was entered through bilateral longitudinal incisions. The patella was freed from the fractured end of the femur with a chisel. A transverse osteotomy of the lower end of the femur was done, following the fracture lines, and the fracture reduced. A lateral phosphor bronze wire suture was introduced to retain the fractured femoral end in apposition. A small flap of fascia lata was thrown across the denudation of the articular surface of the patella, and held in place by chromic catgut sutures on both sides of the patella. The wound was closed with buried suture of chromic catgut and skin sutures of silkworm gut. A plaster-of-Paris bandage was applied over the gauze dressing, extending from the crotch to the toes. No extension was neccessary for the reason that the articular surface of the femur and tibia were not injured, and the flap interposed was not subjected to pressure. The patient made

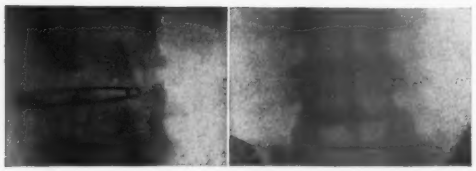

Fig. 23 (at left). Roentgenogram of Case 7 showing disease of the fourth lumbar vertebra. A safety pin is used as a marker.

Fig. 24. Roentgenogram of Case 7 showing the Albee bonegraft and correction of the deformity.

an uneventful recovery, with good motion in the joint. He walks without a limp.

CASE 5. Bony ankylosis from fracture-dislocation of elbow. Colored girl, age 15, fell from wagon in December 1916, dislocating and fracturing the elbow. There was rigid ankylosis of the joint almost at a right angle. The arm was held in a most useless position. Murphy arthrodesis was done March 1917, with results shown in photograph.

CASE 6. Osteitis cystica fibrosa. Mrs. P. D., married, age 27. Family history negative. Personal history negative, except that at the age of eleven she fell suddenly while walking, striking her right hip. Being unable to arise from ground, she was taken home and treated for fracture of hip. She was in bed six weeks with extension applied. The right leg was shorter, and as she began to walk it appeared that the shortening was slowly but progressively increasing. From the time of injury, the hip has never been without discomfort. There is a feeilng of fullness deep in, with occasional sharp pains. The patient was admitted to the Vaughan Memorial Hospital December 16, 1916. She was a

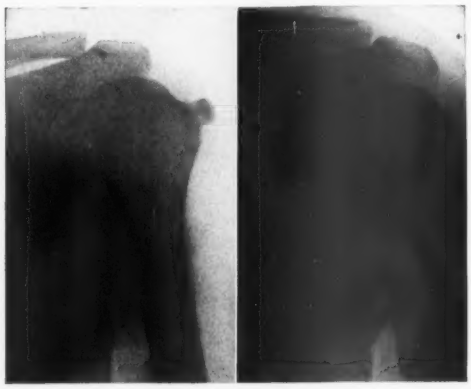

Fig. 27 (at left). Roentgenogram of Case 8 showing exostosis of humerus.

Fig. 28. Roentgenogram of Case 8 showing condition after removal.

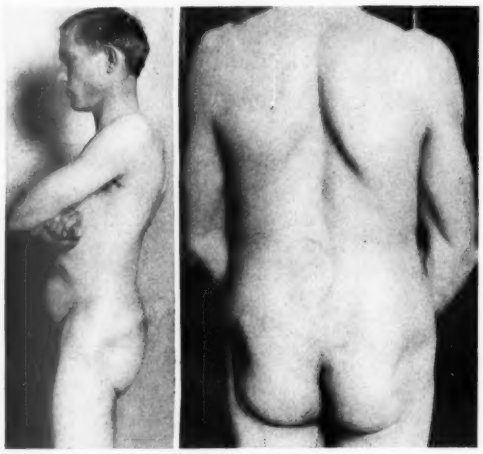

Fig. 25 (at left). Lateral view of Case 7 showing almost complete correction of lordosis.

Fig. 26. Photograph showing back and operative scar.

fleshy woman, with four inches shortening of the right limb and bowing of the right thigh. There was very slight limitation of motion, and no pain in the joint. There was slight tenderness over the upper half of the shaft of the femur, with palpable enlargement.

X-ray exposure showed cystic degeneration with consequent bending of the upper end of the shaft of the femur. Operation was done, December 12 1916. A section of bone was removed with twin saws over all the cystic area. The cysts were curetted thoroughly. The trabeculæ dividing them were not disturbed. Into these large cyst cavities were placed bone clippings, using segment removed for this purpose. A graft was then removed from left tibia, including the periosteum and endosteum, and fitted into the hiatus. Several cross sections of the graft were made with the saw, in order that it could be bent to conform to the shape of the curved femur. Recovery and healing of wound occurred without incident. A subsequent X-ray picture shows filling of the cystic area with bone. The absence of aching and sense of fullness in the leg is evidence of cure of the disease. The tonsils were removed, and she was referred to a dentist for necessary work of teeth. She was discharged from the hospital, January 14, 1917.

CASE 7. Potts disease — lordosis. T. E. P., white, married; age 28; boilermaker; member of a large family. History negative, except that one brother has tuberculosis, but he has not been living in the same house with the patient since it was contracted. The patient has never been ill except for attacks of malarial fever in 1907, and frequent attacks of tonsillitis during childhood. He has not been injured except for a sprained arm, caused by a

fall from the house when he was ten years old. Present illness began in 1911 and was accompanied by pain in the sacrolumbar region. He was unable to turn over if lying on his back, he tired easily, and had to rest frequently while at work. The X-ray was negative at that time. In 1915 he quit trade of boilermaker, and opened a retail grocery, at which he suffered less discomfort. He entered the Navy Yard at Philadelphia in 1916, but was unable to stand the work. He came to Montgomery to work at his trade, but was forced to give it up. Two months later, September 30, 1917, he entered the Vaughan Memorial Hospital, on account of pains in back and limbs; frequently falling when on his feet, and unable to walk any distance. Examination showed lordosis. The spine of the fourth lumbar vertebra was displaced forward, forming a decided depressed space over this vertebra. The X-ray showed displacement and partial destruction of the body of this vertebra. On October 1, 1917, Albee's operation was done, interposing a tibial graft between the split spinous processes of all five lumbar vertebræ and the spinous process of sacrum. He was kept on the frame two and a half weeks; in bed two months. Recovery was made without incident. His back feels strong, and he is anxious to resume work.

CASE 8. Exostosis of humerus. Mr. W., white, age 40, single, cigarmaker. Past history negative. Stiff and painful shoulder. Consulted me October 9, 1917, complaining of inability to raise arm, and of pain on any movement of shoulder. Tender on palpation over deltoid. Passive movement painful. No ankylosis. Temperature and pulse normal. No history of injury. X-ray plate showed exostosis near joint; situated a half inch from articular surface of upper end of humerus. Operation done, October 9, 1917. On chiseling through the base of the growth, it was found to be a thin shell of bone filled with a cheesy mass, and dipping deep into the shaft of the bone. This was a tubercular infarct. This cavity was thoroughly curetted, and filled with a strip of muscle tissue, reflected from the deltoid, and held in place by a catgut suture. X-ray shows result obtained.

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TECHNIQUE OF URETEROVESICAL ANASTOMOSIS

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THIS operation is often indicated, but as my article deals only with the technique of the operation, no attempt will be made to go into details regarding the conditions under which it is to be done.

Suffice it to say that it is called for (1) after some operations or labors in which the ureter is injured; (2) where in the course of some other operation a deliberate resection of the ureter is made; and (3) in certain cases of ureteral obstruction or stricture.

Before attempting such an operation it must be determined that it is technically possible and advisable. If the injury or obstruction is situated so high that a proper anastomosis can not be made, it is of course folly to attempt the operation. If as a result of ureteral obstruction or infection the kidney is badly damaged, or the combined function of the two is low, or there is a recurrence in the pelvis of carcinoma, such a procedure is unwarranted.

With our present methods of examination all of the above can be determined, and must be, before any operation is considered. A successful anastomosis is of no use if the kidney on the side operated upon has no functional value.

The technique of the operation varies, depending upon whether the anastomosis is made at the time of injury to the ureter, or as a deliberate procedure for ureteral fistula or obstruction. The actual joining of the ureter to the bladder is the same when the operation is done for operative injury to the ureter, ureterovaginal fistula, or stricture, so no separate description will be given.

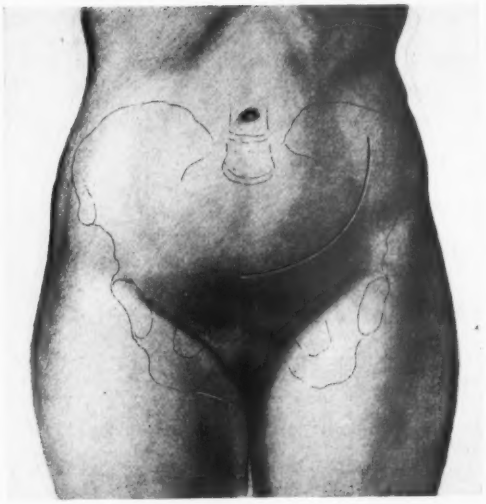

Fig. 1. Outline of incision. From one inch above symphysis upward and outward to a point one inch internal to anterior superior spinous process of the ilium.

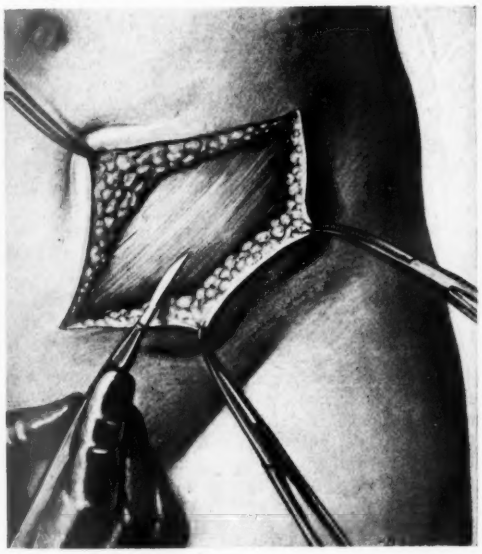

Fig. 2. Incision through skin. Fibers of external oblique to be separated.

Fig. 3. Incision through external oblique. Internal oblique shown.

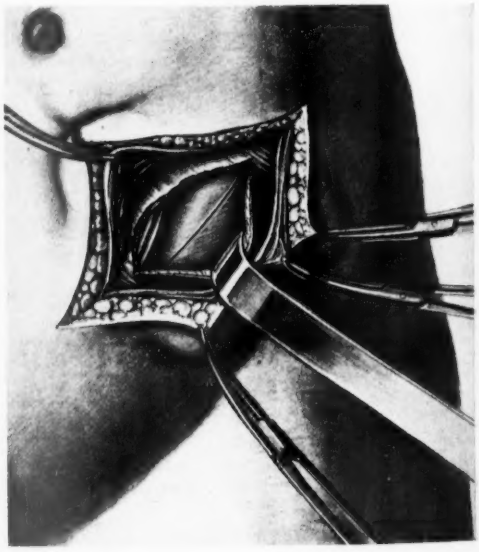

Fig. 4. External and internal oblique have been divided. Deep on the inner side is seen the rectus. The line shows the direction in which the transversalis fascia is to be incised. (In practice the internal oblique is divided more extensively than is here shown.)

Fig. 5.

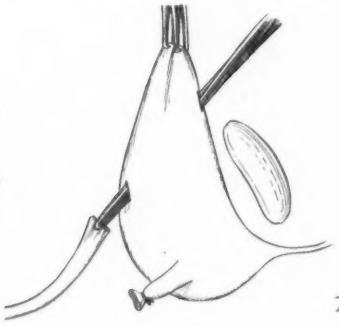

Fig. 6.

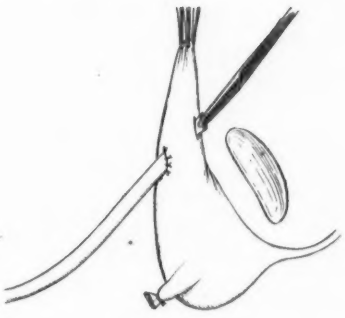

Fig. 7.

Fig. 5. The ureter has been double clamped. It is to be divided between the clamps and the caudal portion ligated.

Fig. 6. Bladder elevated with two Allis clamps. Forceps have been passed through and the cephalad portion of the ureter grasped in the forceps.

Fig. 7. Ureter has been drawn through bladder and united to posterior wall by separate sutures of silk.

The incision which I have found best is a modification of the Pfannenstiel, the modification being that it is one-sided and prolonged outward and inward to, or slightly beyond, the median line.

Such an incision begins one inch above the symphysis, at the median line (or an inch to the opposite side) and extends in a curved direction upward and outward to a point one inch to the inner side of the anterior superior spinous process of the ilium. The first incision extends down to the aponeurosis of the external oblique; this and the internal oblique are divided in the same general direction as the skin, but the curve is flatter. The fibers of the external oblique are really separated, but many of the internal oblique fibers are divided obliquely.

This brings the incision down to the transversalis fascia, which is so intimately connected with the peritoneum and is often so thin that it is difficult to incise it without opening into the abdominal cavity. This incision is best started with a very sharp knife; after the line of cleavage is struck, there is no difficulty in separating the transversalis fascia from the peritoneum. Should the peritoneum be opened, it is best to establish the line of separation between it and the peritoneum before closing the latter.

After passing through the transversalis fascia, by blunt dissection the peritoneum is stripped from the pelvic wall. The large iliac vessels come into view, and after the dissection is continued well to their inner side, an attempt is made to find the ureter. *This is always to be found in the peritoneal reflection.* In nearly all the cases where this operation is indicated, the ureter is much above normal size, and so is the more readily recognized.

After locating the ureter it is lifted upward by applying a pair of Allis clamps, in such a way that the teeth meet beyond the ureter itself. The ureter should never be clamped, as such an injury may so impair its vitality that necrosis may result. By applying Allis forceps successively lower and lower and at the same time using blunt dissection the lower end of the ureter (or the point of obstruction, or the fistula) is reached. Occasionally it is necessary to ligate and divide the uterine artery or the round ligament, but usually these can be pushed aside by suitable retractors.

At this stage moderate Trendelenburg elevation is an advantage.

After determining the point of ureteral division, the ureter is double clamped and divided. The lower end is ligated with chromic catgut, more to prevent troublesome hæmorrhage from a small

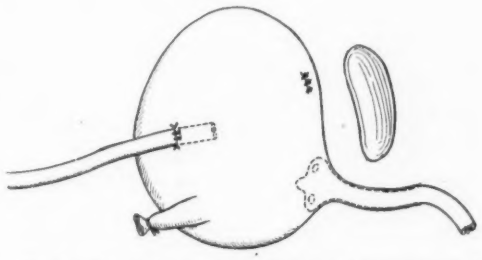

Fig. 8. This shows (1) ligated ureter; (2) ureter sutured to bladder wall and projecting into bladder; (3) closure of puncture of anterior wall; (4) retention catheter in bladder.

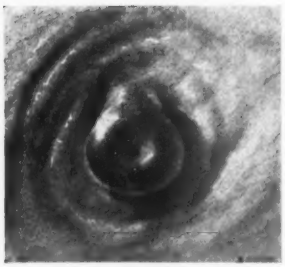

Fig. 9. Appearance of ureter two months after operation.

vessel that is generally found under the ureter, than to prevent reflux of urine from the bladder.

The cephalad end of the ureter is then dissected free from its attachments for three-quarters of an inch, but no more. This I regard as essential for further liberation imperils its blood supply.

Next, the most prominent portion of the bladder is picked up with sponge forceps and that part of the bladder so mobilized that an easy approximation of it and the ureter can be effected. After this, a big bite of the bladder is picked up with two Allis clamps, one inch apart, as shown in the drawing. A sharp pair of artery forceps is then passed through the part of the bladder so elevated, the forceps passing through the anterior wall, entering the bladder cavity, and passing through the posterior wall. The end of the ureter that is held by forceps is then passed into the jaws of the forceps used to puncture the bladder. By traction the ureter is drawn through the walls of the bladder. While held in this position the ureter is sutured to the posterior bladder wall by five or six sutures of fine silk, taking care to see that at least one of these approximates the bladder and the peritoneum where it and the ureter come together. This prevents traction on the other sutures.

The end of the ureter is now released from the forceps, and the Allis clamps taken off the bladder. By elevating the anterior wall where it was punctured, the end of the ureter is made to enter the bladder cavity. It is well to have three-eighths to one-half of an inch projecting into the bladder. The opening in the anterior wall of the bladder is closed with a few sutures of fine chromic catgut. Where there is traction on the suture line, it is best to anchor the bladder to the pelvic fascia to relieve this tension.

A cigarette drain is inserted and the wound is closed with plain catgut in layers, except for the skin which is closed either by interrupted silkworm-gut sutures, or silkworm-gut sutures and Michel clamps.

A retention catheter is placed in the bladder.

The dressings are to be changed every twelve hours as there is apt to be a large amount of serosanguinous discharge. The drain can be removed in 48 to 60 hours.

The retention catheter should be removed once daily and cleansed; otherwise it may become stopped with phosphates and act as a plug.

The patients are put on urotropin before operation and this is resumed as soon after as the stomach conditions permit.

This method of making the anastomosis has several advantages. Over that of passing a forceps through the urethra and then puncturing the bladder it has the advantage of simplicity, no need for disarranging the position of the patient, no need for an extra assistant, besides greater surgical cleanliness. The puncture in the anterior wall is of no consequence.

To open the bladder and then anastomose the ureter is more difficult; the opening made is always larger than desired, and whereas such an opening can be closed, I do not believe the chances of good union of the bladder and ureter are as certain as by the method I have described.

There is no necessity for splitting the end of the ureter to prevent stenosis. The point at which stenosis is apt to occur is not there, but where the ureter passes through the bladder wall.

While the chance of union is better if the anastomosis is made on the peritoneal bladder surface, I feel that the increased safety as regards life, of the extraperitoneal operation more than compensates for the slight disadvantage.

In a few months the greater portion of the ureter projecting into the bladder disappears.

In the cases I have observed there has been no impairment of renal function, and in some cases where previous to operation there was infection and diminished function, both have improved.

BUNION, ITS CAUSES AND CURE[1]

By H. A. ROBINSON, M.D., Kenosha, Wisconsin
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IN November, 1915, I was called to treat the injured foot of a railroad employee. As is my custom in all such cases, I took an X-ray to see whether or not there were any fractures. I was rewarded by being able to say positively that there was a fracture of one of the metatarsals. The roentgenogram also showed a peculiar condition which I had never noticed before, namely, that the sesamoid bones were enlarged. I also observed that the man had a bunion.

Soon after this I treated a foot injury of another railroad man. This man had two very large bunions and while X-raying the injured foot for fracture I had him place the other foot on the plate. Thus I was able to compare the two feet and I found that both showed the same peculiarity as mentioned above. I began to wonder if this peculiarity might not be the long looked for cause of bunion. Later I dissected feet which it had been necessary to amputate. I operated and found that when the sesamoids were removed the bunion was easily reduced and I came to the conclusion that—

Bunion is due to a dislocation of the metatarsophalangeal articulation of the great toe. Contrary to previous theories it is not produced by tight, ill-fitting shoes with high heels or pointed toes but is caused by pressure from within.

Heredity is a great factor in the development of these deformities; parents or relatives not far remote who have been so afflicted can be traced in almost all cases. For instance, the first patient operated upon by my method had three sisters and two brothers with halux valgus and their father was a great sufferer from the condition. The next patient operated upon said that her father died when she was a little girl but she remembered that his feet were like hers. I could enumerate many cases to strengthen this theory but it is an easy matter for any who wish to investigate for themselves to find further examples.

Dwight has described a supernumerary bone which occasionally exists between the bases of the first and second metatarsals and to this bone he has given the name of intermetatarsem. J. K. Young believes that Dwight's bone is the cause of some cases of halux valgus and that its early removal arrests the condition and relieves all symptoms.

I shall consider only two forms of bunion: First, the usual type which develops on the inner side of the great toe joint (and by inner and outer I refer to the foot with reference to the middle line of the body and not the median line of the foot). In this form of bunion the head of the metatarsal bone is displaced inward. In the second form the head of the metatarsal bone is displaced upward and there results a bunion on top of the foot. The cause is the same in each case and the only difference is the direction from which the villain attacks the innocent unsuspecting first metatarsal bone.

The onset is very insidious and the patient is unaware of his predicament until the joint is considerably enlarged and the foot swollen and painful. Then in looking for a cause he invariably blames the shoe for an offense of which it is entirely innocent. Many times the shoes are discarded and new ones take their place. The patient tells the shoe fitter that the old shoes were too tight across the ball of the foot and suggests a size wider. This relieves for only a short time because the head of the metatarsal continues to spread and soon a size larger is needed. This process is continued until the feet are unsightly when a chiropodist is consulted. He again blames the shoe for the trouble and tries all sorts of apparatus for the relief of the deformity. Yet it stays, and this is not surprising since we believe we know what causes the trouble.

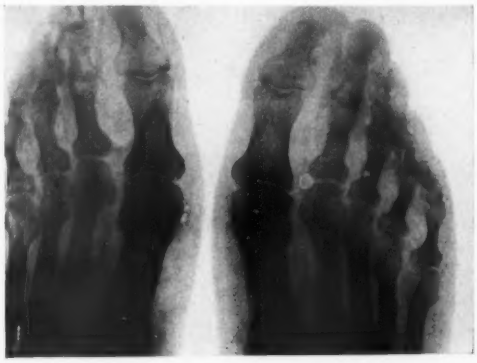

Fig. 1. Roentgenogram of normal foot.

[1] Read before the Kenosha County Medical Society, Kenosha, July 19, 1918.

Fig. 2. Roentgenogram of a case of bunion showing the sesamoids enlarged and producing a dislocation inward of the head of the first metatarsal bone.

Fig. 3. The result of operation in case shown in Fig. 2.

If bunion is a dislocation of the head of the metatarsal bone inward toward the median line of the body, how could a tight shoe produce it?

I can show numerous cases with enormous bunions and almost complete dislocation of the joint, who never wore a tight shoe; then, too, I can show a great many people who have worn very tight shoes all their lives and who have no signs of bunion.

Some contend that high heels are a frequent cause but many people who have worn high heels more or less all their lives have no bunions.

Pointed toed shoes are a more logical cause but again I can show people who have worn pointed toed shoes all their lives, yet, they have no bunions.

In all cases of bunion, large or small, whether they have worn tight, pointed toed shoes, high heels or broad roomy shoes, there is one thing in common which I claim to be the cause, namely, enlarged sesamoids.

Fig. 4. A lateral view of foot showing enlarged sesamoid which points straight downward dislocating head of metatarsal bone upward and producing a bunion on top of the foot.

I will endeavor to explain how the bunion on the inner side of the foot develops.

The two sesamoids which develop normally under the head of the first metatarsal bone enlarge and grow downward and outward toward the head of the second metatarsal, and as the plantar fascia is tough it resists the sesamoids and with each step pushes them upward and inward and causes the head of the metatarsal to give in the line of least resistance, which is upward and inward.

Because there is no pressure inward on the proximal phalanx of the great toe, it is held firmly by the strong ligaments and gradually the head of the metatarsal is displaced inward. This turns the great toe outward toward the other toes until in many cases the head is almost completely dislocated from the articular surface of the phalanx. The roentgenograms show that this dislocation corresponds to the size of the sesamoids.

Bunion occurs on top of the foot when the sesamoids are enlarged and point straight downward toward the sole of the foot. The tough plantar fascia forces the sesamoids upward against the head of the metatarsal so as to displace it perpendicularly upward and the phalanx being held firmly to the tendon is not displaced. This produces a bunion on top of the foot. The cure in both cases is the same, namely, removal of both sesamoids.

By way of preventive surgery, I would advise the removal of both sesamoids as soon as the first symptoms of bunion are discovered, which

can be readily done by the X-ray. Then no further development can take place and the patient will be spared the hideous disfigurement of the feet as well as the suffering, which eventually comes if operation is delayed.

To remove the sesamoids an incision is made commencing at about the under surface of the head of the metatarsal and one-half to three-fourths of an inch back of the protuberance. The prominence is encircled to a point a short distance in front of the joint and on the phalanx, and the flap reflected downward leaving the bursa intact. Then if there are any sharp points or prominences on the inner side of the head, the bursa is reflected forward on the phalanx and the prominences removed with a sharp chisel. After removing the sesamoids the bursa is replaced over the denuded bone and sutured to the periosteum. The head of the metatarsal can be easily replaced and the toe will come around into position. Then the outer flap is sutured after introducing a small silkworm drain and the wound dressed: It is a good plan to put a small wood splint on the inside of the foot and to bind the great toe to it and to bandage the foot tightly. When the foot is healed a good snug or even tight shoe will be comfortable to the patient.

CRANIAL DECOMPRESSION FOR HEAD INJURIES ACCOMPANIED BY SIGNS OF INCREASED INTRACRANIAL PRESSURE[1]

By R. L. PAYNE, Jr., M.D., F.A.C.S., Norfolk, Virginia.
Surgeon, St. Vincent's Hospital.

SINCE 1909 I have written several papers on the subject of fracture of the base of the skull, reporting some of my work and recommending that temporal decompression be always done whenever these cases develop a certain degree of increased intracranial pressure.

From that time up to the present I have been astonished at the indifference many doctors show, especially those doing and seeing little surgery, to this subject of severe head injuries and I wish to report again my small experience in this work.

In considering the value and advisability of subtemporal decompression in skull and brain injuries, the burden of proof would naturally fall on the results obtained with and without operation in a given series of skull fractures. Unfortunately, up to the present time, these statistics have been based on the total number of fracture cases coming under a given surgeon's experience and I here wish to express the view that such deductions are erroneous and do not permit of truthful conclusions.

I think we all agree that all demonstrable depressed fractures and those showing focal symptoms need some operative treatment and with this type eliminated there is then left two distinct varieties of head injuries, namely, mild and severe, in which the classification depends entirely on the surgeon's ability to determine whether there is or is not a marked increase of intracranial pressure. In the mild type the intracranial pressure is slightly raised, soon returns to normal and there is no necessity for an operation, but the question of subtemporal decompression in these cases depends largely on the accurate determination of just what the intracranial pressure is doing. The very fact that this determination can be definitely carried out at once places these mild cases beyond possible operative interference and, therefore, should eliminate them from statistics presented with the view of estimating the value of subtemporal decompression in head injuries.

It is only in the severe types of head injuries with marked increase of pressure that decompression should be considered and, therefore, the severe variety alone should be included in records collected for the purpose of determining the value of subtemporal decompression in these cases. On the other hand many of these severe head injuries suffer profound shock and such severe damage to the medulla that death occurs at once or in a few hours. These cases, therefore, never come within the realm of an operative possibility and hence should not be considered in our statistics.

I think we might say approximately that any severe head injury living eight hours after injury should be considered an operative possibility and studied carefully with the view of determining whether a decompression should be done.

[1] Read before the Southern Surgical Association, St. Augustine, Florida. December 19, 1917.

Many cases, however, recover from the initial shock within the first one or two hours and in these instances investigation of the various clinical signs of increased pressure should be started at once. When the increase in intracranial pressure rises definitely high one can never tell how soon the fatal stage of medullary collapse may occur, therefore if operation is indicated it should be done as early as possible.

The greatest mistake now made in the treatment of these cases is that of waiting too long when operation is indicated. Some of the operative deaths have undoubtedly been due to interference before recovery from the initial shock but the greatest error made in these cases and the hardest to avoid is that of delay when once the intracranial pressure has reached a high degree. This brings us to the consideration of what are the indications for subtemporal decompression in these cases.

If a patient sustaining a head injury does not die within the first few hours, there is first recovery from the initial shock, the blood pressure gradually rises to about normal and then the signs of increased intracranial pressure may be studied for the first time. These signs are to be found in the pulse rate, the eye-grounds, the spinal pressure, and the systemic blood pressure. The pulse rate and general blood pressure should be recorded every thirty minutes, the eye-grounds examined every hour and the spinal pressure estimated one or more times according to the indications for or against this procedure.

If there is an extremely high rapid rise in intracranial pressure, there will quickly develop medullary compression with œdema, and in this state we will have a fast, increasing pulse rate, a fall in blood pressure, negative eye-grounds and a low spinal pressure. It is needless to say that this is the fatal state and any operation undertaken in this stage would only hasten the end. If the rise in intracranial pressure is slow but gradually increasing, there will occur a slowing of the pulse, engorgement of the retinal veins and a rise in both the systemic blood and spinal pressure.

Some surgeons do not attach much importance to the question of blood pressure and in this connection it is to be recorded that we do not get an increase in blood pressure until the rise in intracranial pressure equals that of the general circulation. Irritation or stimulation of the vasomotor centers then occurs, the general blood pressure rises a step of from five to fifteen millimeters and is simply nature's method of overcoming medullary anæmia. There is never an increased blood pressure early when associated with only a mild increase of intracranial pressure. I have found that blood pressure readings are often of material value, and, once this pressure has risen high and begins to fall, an operation in my experience has always been futile.

When the intracranial pressure attains sufficient height the return flow in the retinal veins is obstructed with a resulting dilatation and if the condition progresses there will occur first an obscuration of the nasal half of the eye-ground and later a total blurring will develop. This sign will often be found in only one eye as several of my cases have shown.

In considering the four cardinal signs of increased intracranial pressure, I feel that the change in pulse rate is not only the most readily observed but the most dependable symptom in our present knowledge. This is probably due to the fact that, of the three vital centers in the medulla, the vagus is not only the most stable but responds more rapidly to stimulation. When a pulse of 80 or more gradually falls to 60, we should strongly consider a relief of the intracranial pressure. A greater drop to 55 or 50, coupled with retinal œdema and a rise of the blood and spinal pressure is positive indication for an immediate decompression.

The value of spinal pressure estimations in these acute cases is sometimes valuable but ofttimes dangerous. It should never be done when there is a high blood pressure or during the stage of marked increase in intracranial pressure. Several deaths have been reported following this mistake. This procedure is probably of more value in subacute and chronic cases and should only be utilized early in the acute cases before there is a decided rise in intracranial pressure.

It is a mistake to wait in these cases for a development of all the signs of increased pressure before operation is undertaken. Experience after all is the best guide and watching some of these cases will teach a surgeon to decide upon operation when only two of the cardinal signs are present. For instance, a pulse of 50 coupled with partial optic œdema, or a pulse of 50 coupled with a rise in spinal pressure to 20 millimeters on a mercurial manometer or a slow pulse, a rising blood pressure of two steps coupled with either optic œdema or increased spinal pressure are entirely sufficient to warrant operation.

In grave cases with very high intracranial pressure unrelieved by decompression there will occur, sooner or later, an exhaustion of the vasomotor and vagus centers. This is indicated by

a rapidly rising pulse rate and a falling blood pressure and invariably means medullary œdema and approaching medullary collapse. These symptoms following a previously slow pulse and high blood pressure in such a case are, therefore, positive contra-indications for operation. I have never seen a case of acute high intracranial pressure with a pulse of 45 to 50 recover by operation if the case was left unoperated until the pulse on the secondary rise had reached ninety five. If there is any hesitation whether operation should be done in a case showing the cardinal signs of a high increase in intracranial pressure, this doubt can be at once dispelled if the pulse rate suddenly increases fifteen to twenty beats.

Textbooks quote the mortality of basal fractures from 50 to 90 per cent. The most reliable data in print today is from William Sharpe. Carefully analyzing his reports[1] would permit one to arrive at the following deductions:

From first report to June 1, 1914:

Fifty-seven cases possible for operation but not necessarily indicated.

	Number	Per Cent
Cases not operated upon	21	
Recovered	3	14
Died	18	85
Cases operated upon	36	
Recovered	27	75
Died	9	25
Cases possible for operation	86	
Cases not operated—all died	11	
Cases operated	75	
Recovered	54	72
Died	21	28

In arriving at these deductions from Sharpe's cases we have eliminated, as previously mentioned in this paper, those cases having only a slight temporary rise in intracranial pressure and the moribund head injuries dying a few hours after admission. Certainly these two types would never come within the realm of an operative possibility and, therefore, should be excluded from statistics bearing on the value of the operative procedure. For the same reason I herewith report my experience with 29 head injuries accompanied by signs of high intracranial pressure in which the operation of subtemporal decompression was done on every case.

Twenty-two or 75.86 per cent of these cases recovered while seven or 24.14 per cent died. Some of the deaths in my cases, occurring in my earlier experience, were undoubtedly due to delay in operating until medullary œdema had begun. In my last seven successive cases chosen for operation there has been only one death following decompression.

In considering statistics there is further chance for error as follows: First, because the patient died without operation that therefore he would have lived if operation had been performed. Second, we say a series of cases might be possible for operation; this is tentative depending on their condition and certainly does not mean that operation is indicated in all of them. Third, I do not think that any surgeon can assume, just because operation resulted in recovery that, therefore, the patient would have died without operation.

Some of these high pressure cases occasionally recover without operation but practically all of them have to reckon afterward with post-traumatic brain and general nervous symptoms which, it is reasonable to believe, would have been forestalled by a timely unilateral or bilateral decompression.

In view of the operative recoveries reported and the absence of post-traumatic symptoms following a timely decompression I again take the position that our results will be much better in these cases, if, with the proper indications present, we help relieve the threatened danger to the medulla and rest of the brain by a cranial decompression.

[1] Operative Therapeusis, vol. ii, 656; Surg., Gynec. & Obst., 1917, xxiv, 29.

A NEW OPERATION FOR THE CURE OF FEMORAL HERNIA

By J. W. DOWDEN, F.R.C.S. (Edin), Edinburgh, Scotland
Senior Lecturer in Clinical Surgery, Edinburgh University

ALMOST every surgeon will agree that the radical operation for the so-called cure of femoral hernia is unsatisfactory. Recurrence is humiliating, and not at all uncommon. Various operations have been carried out with more or less satisfaction. The operation described below has been performed by me on a great many patients during the past year in my wards of the Edinburgh Royal Infirmary, but sufficient time has not yet elapsed for the results in the later cases accurately to be estimated. If the following paper elucidates sufficiently my method, readers will probably agree that there ought to be no failures. The causes of failure in the ordinary operation, are due to the rigid walls around the femoral ring which are not amenable to sound and reliable approximation.

The principle of my operation is the placing of a ball of fat or other tissue, bigger than the abdominal aspect of the femoral ring, and fixing the ball *in situ*, the ligated sac of the hernia being displaced above the ball. The result of this is that the greater the intra-abdominal pressure, the more this ball is forced against the femoral ring, thus effectually closing it. All operations ligating the neck of the sac only, or displacing it upward, are liable to recurrence. Roux's operation of inserting a staple through the inguinal ligament (Poupart) and into the pubic bone, cannot always be carried out. Nicoll, of Glasgow, bored holes in the pubic bone, and approximated the inguinal ligament by a silk stitch, which passed through these holes as well as the inguinal ligament, in the shape of a mattress suture.

Baldwin's method and MacEwen's method most closely approach mine. Both utilize the sac to form a buffer, and these are the soundest methods. My method is simply a more certain buffer, and even if this buffer is converted into fibrous tissue, it will be effectual.

Description of method. An incision about 4 inches long is made, a little below and parallel to the inguinal ligament (Poupart), with the center over the site of the hernia. The fatty coverings of the sac are exposed, and by gauze dissection and with scissors easily cleared up to the femoral ring. Not only should they be cleared to the ring, but with a blunt dissector or Mayo's scissors, cleared from the femoral ring as well. As a rule, by pulling on the fatty coverings and the sac, this can easily be done. The fatty coverings are often quite thick, as will be found on clipping through them in order to open the sac, which should now be done, and a careful search made for the adherent omentum or other structures. Redundant and adherent omentum if too large to replace, is ligated and cut off. This excised portion is carefully preserved, either in a corner of the wound or in warm normal saline solution. The next stage of the operation is to revert to the skin and fascial incision. The upper margin of the incision is dissected still further upward, exposing the inguinal ligament and the aponeurosis of the external oblique for half an inch or more (depending on obesity) above the inguinal ligament. An incision is now made through the external oblique aponeurosis, about a quarter of an inch above the inguinal ligament, and extending from the pubic spine for one inch or more, upward and outward, parallel to the inguinal ligament. This incision opens the inguinal canal, and the cord or round ligament must be displaced inward. Forceps are placed on the edges of the external oblique aponeurosis, for the purpose of suturing at the termination of the operation. The transversalis fascia is next incised through this incision, but care must be adopted not to carry the incision too far out, lest the inferior (deep) epigastric artery or its accompanying veins be injured. The extraperitoneal fat of varying density is now exposed, and the abdominal aspect of the femoral ring is sought. We leave this incision and pass to the lower. The sac and its fatty coverings have been defined. By following the size of the femoral ring, it is judged whether the sac and its coverings can be pushed from the thigh to the abdominal side of the ring in its entirety, or two halves pushed up separately. Either grasping the sac with curved forceps from below and pushing the curved forceps through the ring with the sac, or else passing from above a pair of curved forceps and seizing the sac, does not matter very much, provided the sac and its coverings are displaced and pulled out through the upper incision. If the sac and coverings are too large, they should without any hesitation be cut off, and carefully kept as is the portion of omentum, to be utilized later. The remains of the sac are then easily displaced upward. If, for instance, the sac and its

coverings have been brought out through the upper incision, the neck of the sac is transfixed with catgut on a needle, and firmly sutured. The ends of the ligated catgut are left long so as to identify the neck of the sac if required. Now a ball valve is to be made. If the sac and its fatty coverings have been transferred to the abdominal aspect of the femoral ring, it is judged by the size of the ring, whether the bunched up sac and coverings will form a ball about half as big again as the abdominal opening of the ring. If so, a needle and catgut are utilized to stitch the sac across and about in various directions until a ball is formed, and the last stitch being through the part which will form the lower surface of the ball. These stitches should not be pulled too tightly, and the primary end and terminal end of catgut used should be left long. A pair of curved forceps or Cleveland needle is passed from the lower opening through the femoral ring to the abdominal aspect, and the two ends of this catgut stitch left from forming the ball are grasped and withdrawn on to the thigh. One of these free ends of catgut is now threaded on to a sharp needle and passed through, securing a good hold of the pectineal fascia. The needle is now removed and the two ends of catgut which have passed through the femoral ring are knotted firmly together. This is done with the object of snugly pulling the ball valve down on the abdominal aspect of the femoral ring. The ends of catgut on the neck of the sac are now cut off, and the transversalis fascia and external oblique aponeurosis sutured. An appendix inverter or pair of fine dissecting forceps may be required to push the ball valve out of the line of this suture.

If this sac does not form a satisfactory ball, or if the sac has had to be cut away to enable the transposition of the hernial neck to the abdominal side of the ring, excised omentum or sac coverings can be utilized separately to form a sufficiently large ball. If these are insufficient, it is usually possible to obtain as much fatty tissue as is necessary from the abdominal wall or from the thigh. The deep layers of the incision are now sewed together, and the skin wound approximated. The only case that I have had trouble in, was one in which one of the inferior (deep) epigastric veins was injured.

The operation for the first time seems to the operator somewhat tricky and a little difficult, when dealing with the incision on the abdominal side of the inguinal ligament, but with a little practice and the help of small retractors, this is overcome. In fact, one can look down on the femoral ring from the abdominal side, and see the arrangement of the blood-vessels about it.

When dealing with a strangulated femoral hernia, the incision above the inguinal ligament is of great help, because not only does it enable the surgeon more easily to reduce the hernia, but also allows free inspection of the constricted area of intestine. The sac having been opened and the condition of the gut considered, the second incision carried out above the inguinal ligament is then made. The peritoneum is opened and the entering portions of intestine are drawn out through the upper wound, and by means of gentle traction of first one portion and then the other, associated with gentle taxis of the obstructed intestine in the sac below the ligament, is followed usually by an easy reduction, and the coil can then be drawn out of the upper incision and examined in its entirety. The radical operation as described can then be carried out in the majority of cases. There is more difficulty in operating on hernias recurring from other methods, as the sac is adherent to the femoral ring.

TRANSACTIONS OF SOCIETIES

CHICAGO SURGICAL SOCIETY

REGULAR MEETING, MARCH 1, 1918, DR. CARL BECK, PRESIDENT, IN THE CHAIR

ELECTRIC LIGHT AND HEAT IN THE TREATMENT OF INFECTIONS

Dr. A. J. Ochsner read a paper on the value of the electric light and heat in the treatment of septic conditions (see p. 328).

DISCUSSION

DR. WILLIAM M. HARSHA: I would like to ask Dr. Ochsner with reference to the candle power.

DR. OCHSNER: We use lights of different candle power according to the heat the patient can bear comfortably, although we usually use a 32 candle power light.

DR. E. M. SALA: Do you ever get any burns from these lights?

DR. OCHSNER: No. If the Burdick light which we prefer is too hot, the patient can press a button which is alongside of him which will reduce the heat to one-half the original strength.

DR. SALA: How long do you continue the treatment?

DR. OCHSNER: Some patients will have the light on all night long; others will use it for one or two hour intervals.

DR. CARL BECK: Since Dr. Ochsner called my attention to this method of treatment we have used it in our hospital frequently and have been very well satisfied with the results.

Sunlight or heliotherapy was discussed very freely within the last few years. Most of us are familiar with the experiments of Rollier and his experience. I became so much interested in the subject that I visited Rollier at Leysin, and I may say that I was amply repaid for my trip there. I saw hundreds of patients who were being treated with light therapy. Rollier has not only resorted to this method of treatment in chronic inflammatory changes of a tubercular nature but also in cases of septic infection.

I might mention a little history in connection with the circumstance which led Rollier to take up heliotherapy. He was an assistant in Kocher's clinic in Switzerland. In this clinic there were a number of cases of septic infections in which the wounds would not heal in the dark rooms of the hospital to which no sunlight found its way. Rollier's wife was afflicted with tuberculosis. He moved up to the mountains of Switzerland for a short time, and while there noticed a case of extensive injury in an old man who was curing himself lying in the sun. He assured Rollier that his sores were healing without any medicine or without doctors. This gave Rollier his first thought of light therapy in chronic inflammatory changes, and he began to bring his cases of surgical tuberculosis and cases of other diseases to the mountains and expose them to the sunlight, and he built one sanitarium after another, until today there are thousands of patients at these sanitaria. Shortly after this they began to use artificial sunlight in the shape of sunlight lamps. You are doubtless all familiar with the Kromayer lamp and with other lamps, and patients have done well under the treatment of these lamps, but in none of this treatment has attention been called to the action of the light or heat on pain and how easily pain can be relieved by the action of the artificial light to which Dr. Ochsner has called our attention tonight. It is much better to use this light than to employ narcotics which are only of temporary use, while these lamps or lights can be used permanently. Interesting, at the same time, is the explanation of Rollier and Bernhardt of the physiological effect of the lamp light and other lights upon the skin. Their explanation is that it stimulates a local leucocytosis. They have made many experiments in Rollier's clinic in regard to this and have found changes in the red blood-corpuscles shortly after exposure to sunlight and after other lights have been used.

DR. THOMAS J. SULLIVAN: We all know very well the value of heat in treating infections of the hand. I have had considerable experience with the use of electric light as a heat factor in handling septic cases acquired in the packing industry. Some of these cases are very bad, and yet healing takes place very quickly by the use of electric light in association with large hot boric acid dressings. A new epoch in surgery was reached when boric acid dressings and heat were used for septic conditions of the hand.

Some one has recommended the use of the Kromayer lamp in the treatment of tuberculous glands of the neck. The Kromayer light will burn the tissues unless care is used in its application. In focusing the light one should cover the surrounding tissue with cotton, having a properly arranged hole cut in the pad. If this precaution is not taken you will burn the skin. I have used this method in cases of tuberculous glands of the neck in girls,

particularly where an operation for cervical adenitis was not desirable, and have been able to limit the size of these glands rapidly by the application of heat. A frequent handicap, however, is the unwillingness of these patients to come to the office for treatment but the result of the treatment is well worth the frequency of the application.

Heliotherapy is a rediscovery of a very old treatment of infections. In this short discussion we may eliminate a review of its use, but instead, mention that it was used and described by Herodotus in 484 B.C. Last summer I made use of it in a case of bilateral tuberculosis of the calcanei.

The patient did better on the roof of the hospital, in the hot sun, than he did in the surgical ward. The exposure was gradual until he remained four to five hours in the sun every available day. Judging from the result of healing of the calcanei I can endorse this method of treatment from personal experience.

DR. EMIL G. BECK: I would like to ask Dr. Ochsner if this method of applying heat has been used in cases of acute articular rheumatism in his hospital.

DR. OCHSNER: It has been used in acute articular rheumatism, also in gonorrhœal rheumatism. The Truax Company of this city have these lamps for rent. If one has a patient in a private house with tuberculous glands of the neck or with septic infection, he can rent one of these lamps for $2.00 a month The lamp can be attached to any electric light and used in that way. It is much more convenient to rent these lamps than to buy them for individual patients. We make use of these lamps in any case of local pain, no matter where it is, or what the cause of it is. I think probably the leucocytosis or the congestion brought about by the use of the heat is what relieves the pain. There is no doubt but what heat produced by light is more penetrating than heat supplied in any other way.

DR. CHARLES DAVISON: I would like to hear Dr. Meyer of the County Hospital speak on this subject.

DR. KARL A. MEYER: Dr. Fantus of the Therapeutic Department of the University of Illinois, who is doing work with light treatment, last year came to the hospital and asked me if he could avail himself of the clinical material to treat a series of cases with electric light treatment. The first series he treated with electric light were cases of gonorrhœal rheumatism. He treated I think 50 cases with excellent results. These are the most intractable cases we have to deal with in the hospital. In our work on the prostate gland we have used large doses of vaccines intravenously, with terrific reactions, but after treating these cases with electric baths during their stay in the hospital the relief from pain has been remarkable. This treatment is used at the Cook County Hospital in treating nephritic cases for sweats, and we find it is much easier on the nurses. We have seven or eight of these apparatus in the medical wards. The medical men are availing themselves of this therapeutic adjunct very extensively. We not only use them in the general medical wards, but in the venereal wards. This treatment is also used by Dr. Brown and Dr. Suker in cases of iritis with terrific pain, and in all sinus infections of the nose and throat.

DR. EMANUEL FRIEND: We are using at the Michael Reese Hospital an apparatus which produces a therapeutic effect similar to these lamp lights exhibited by Dr. Ochsner. It is an electric apparatus allied to the ordinary hair dryer. I do not know whether any of the gentlemen present have used it, but we are using it in chronic joint troubles with very good results.

It seems to me, the rationale of this treatment is the skin hyperæmia which relieves the deep stasis or congestion of the lymph vessels and the blood vessels. In cases of chronic arthritis we have had very good results from this hot air apparatus. I believe this so-called hair dryer is a little more convenient than the lamps would be.

BRACHIOPLEXUS PARALYSIS DUE TO ANEURISM OF THE AXILLARY ARTERY

DR. PAUL MORF reported a case of brachioplexus paralysis due to aneurism of the axillary artery.

NEW OPERATION FOR PROLAPSE OF THE UTERUS

DR. CLIFFORD U. COLLINS, of Peoria, Illinois, described a new operation for prolapse of the uterus (see p. 326).

DISCUSSION

DR. ALBERT GOLDSPOHN: The operation that has been described by Dr. Collins is commendable, in the first place, because it is a vote against the stultifying "interposition" operation first introduced by Schauta, followed by Wertheim and then by Watkins of our city. The objection to that procedure is this, that while these are mostly old women and therefore are less exposed to infection than younger women, yet they are in the world and they are not beyond the reach of infection; and if a uterus so turned into that abnormal position and incarcerated above the anterior vaginal wall, should become infected, as it can as well as through the vagina, then it will be a true *noli me tangere*. Nothing can be done with that except extirpation, and that would be a difficult and mutilating procedure.

An advantage of the Collins' procedure is that it makes a good firm suspension of the uterus above, which is one of the two fundamental things needed. The same thing is done by the Murphy suggestion. But neither the Murphy technique nor this technique is necessary in many instances because most of these uteri are small. In this country we deal with this condition in women beyond the childbearing period mostly. It is not necessary to remove the body of the uterus wholly

or in part, in many of these patients. A firm fibro-fibrous union can be made with the uterus and the tissues in the abdominal wall without doing a hysterectomy. I prefer less operating, namely: by gathering up of the round ligaments with their covering of the peritoneum or broad ligament into a thorough virile strand on each side and implanting these onto punctured wounds through the recti muscles and anterior fasciæ, and in addition doing a thorough, very free suturing of the fundus to the inner rectus sheath and muscle after ample scarification, and finally transfixing the fundus with closing stitches that pass transversely through it. In this way there are three things that hold: first, the round ligaments transfixing the recti sheath and muscle on the sides; second, the fundus being attached after scarification by catgut free stitching to the interior of the abdominal wall; and third, the 2 or 3 closing stitches transfixing it, which can be so placed through a rubber tube externally that they do not cut in and can be left for two or three weeks. I have never known a uterus so anchored to let go.

The next fundamental thing for success in all these cases, no matter what operation you do above, is thorough restoration of the pelvic floor, not merely a perineorrhaphy, but thorough and direct approximation of the levator ani fascia and muscle. But in many old women it is unnecessary to open the abdomen above at all. We can proceed very much as Schauta does with his operation, that I condemn; but instead of turning the uterus completely around so that the fundus faces you turn it half as far, stand it at right angles to the patient's body with the fundus up against the interior of the front vaginal wall, up near the pubic arch, after the bladder has been transferred to the top of the fundus. Then anchor the body of the aterus, as high up as the urethra will permit, firmly against the upper anterior vaginal wall a part that is more highly endowed with inelastic fibrous tissue. We can here make a vaginal fixation that will not let go and put the bladder on top of the fundus with the uterus in its new position. The bladder is the thing to be kept out of the way. It has usually made the trouble in the beginning, finding its way down, insinuating itself and other things following. In this way, with the fundus anchored up high by a vaginal fixation, and the bladder put on top of it, it can do no harm Follow this by restoration of the pelvic floor, and the results will often be equally as good; but voluntary urination will often be more delayed after this operation.

GUNSHOT WOUNDS OF THE KNEE

DR. KELLOGG SPEED contributed a paper entitled "Gunshot Wounds of the Knee," which was read by the Secretary, Dr. Frederick G. Dyas, in the absence of the author.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for revi on the interests of our readers and as space permits.

NURSING TECHNIQUE. By Mary C. Wheeler, R.N. Philadelphia and London: J. B. Lippincott Company, 1918.

DISEASES OF THE MALE URETHRA; INCLUDING IMPOTENCE AND STERILITY. By Irvin S. Koll, B.S., M.D., F.A.C.S. Philadelphia and London: W. B. Saunders Company, 1918.

THE SERIOUSNESS OF VENERAL DISEASE. By Sprague Carleton, M.D., New York: Paul B. Hoeber, 1918.

THE ESSENTIALS OF MATERIA MEDICA AND THERAPEUTICS. By John Foote, M.D., 3d ed. revised. Philadelphia and London: J. B. Lippincott Company, 1918.

LA GANGRÈNE GAZEUSE; BACTEROLOGIE; REPRODUCTION EXPÉRIMENTALE; SÉROTHÉRAPIE. By M. Weinberg and P. Séguin. Paris: Masson et Cie, 1918.

THE HODGEN WIRE CRADLE EXTENSION SUSPENSION SPLINT. By Frank G. Nifong, M.D., F.A.C.S. With an introduction by Harvey G. Mudd, M.D., F.A.C.S. St. Louis: C. V. Mosby Co., 1918.

A TREATISE ON CYSTOSCOPY AND URETHROSCOPY. By Dr. Georges Luys. Translated and edited with additions by Abr. L. Wolbarst, M.D. St. Louis: C. V. Mosby Co., 1918.

SURGICAL TREATMENT; A PRACTICAL TREATISE ON THE THERAPY OF SURGICAL DISEASES; FOR THE USE OF THE PRACTITIONER AND STUDENTS OF SURGERY, vol. I. By James Peter Warbasse, M.D. Philadelphia and London: W. B. Saunders Company, 1918.

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

WILLIAM J. MAYO, M.D., President ALBERT J. OCHSNER, M.D., TREASURER
FRANKLIN H. MARTIN, M.D., Secretary-General

Ninth Annual Session, New York City, October 21-26, 1918

COMMITTEE ON ARRANGEMENTS

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ELIOT BISHOP
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C. G. CRANE
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PRELIMINARY CLINICAL PROGRAM

Clinics in New York City

GENERAL SURGERY

Bellevue Hospital

Nathan W. Green and Eugene Draper — Chest and abdominal surgery, operations and exhibit of cases.

Drs. Vaughan and F. W. Gravelle — Carrell-Dakin treatment of wounds in general surgery.

Donald Gordon and Gaston A. Carlucci — Cases illustrating treatment of compound fracture; special splint for fractured femur.

Frederic Montgomery — Methods of administering ether.

John Rogers — Surgical treatment of thyroids.

George D. Stewart — Stomach and gall-bladder surgery.

John Douglas — Stomach and gall-bladder surgery.

Walter C. Cramp — Acute abdominal surgery; fractures.

George D. Stewart and W. Howard Barber — Results in surgical treatment of ulcer and cancer of stomach, perforating ulcer of stomach, perforating appendicitis. Exhibit from the Surgical Laboratory of the University and Bellevue Hospital Medical College: (a) experiments in uretero-enteric anastomosis; (b) experiments in gastrectomy (partial) and gastro-enterostomy; (c) experimental demonstration in the treatment of ileus and surgical constipation.

F. A. Smith — Surgery of children.

Vincent Gaudiani and George D. Stewart — Construction of kineplastic flaps in amputation.

City Hospital

Nathan W. Green, Joseph Robertson and Dr. Armstrong — Abdominal surgery.

Correctional Hospital

W. Travis Gibb, Frank C. Yeomans and W. H. Stratford — General surgery.

Flower Hospital

Louis R. Kaufman — Nephrectomy; intraventricular salvarsan serum treatment; salvarsan administration by a new apparatus; gastric ulcer (gastro-enterostomy, pyloric occlusion).

Anson H. Bingham — Treatment of tubercular abscess; demonstration of Cabot method; astragalectomy in poliomyelitis cases.

E. Welles Kellogg — Results of fractures treated by mobilization and massage, in comparison to those treated by immobilization (radiographs and patients).

O. R. Von Bonnewitz — Repair of sphincters in fæcal incontinence showing a new hour-glass anal splint; typical case of pruritus ani.

George W. Lutton — Relief of obstructive jaundice.

French Hospital

J. P. Hoguet and M. I. Blank — General surgery.

Gouverneur Hospital

Erward L. Kellog and Albert Sellenings — Acute abdominal surgery.

Hahnemann Hospital

G. W. Roberts, W. G. Crump, H. A. Foster, Sprague Carleton, J. H. Forbes and H. B. Safford — General surgery.

Harlem Hospital

H. A. Haubold — General surgery.

Memorial Hospital

H. H. Janeway — Radium treatment of cancer.

William B. Coley — Treatment of inoperable sarcoma with the mixed toxins of erysipelas and bacillus prodigiosus.

Benjamin S. Barringer — Radium treatment of carcinoma of the prostate and bladder.

Drs. Mallett and Bailey — Method of application of radium.

Metropolitan Hospital

C. L. Bagg, R. F. Ward, W. F. Honan, J. H. Forbes and H. B. Safford — Male surgery.

Mt. Sinai Hospital

Drs. Berg, Lewisohn, Gerster and Beller — Surgery of the stomach, intestines and rectum.

Drs. Wiener, Ware and Thalhimer — Surgery of the bones and joints.

Drs. Elsberg, Taylor and Wilensky — Surgery of the brain and spinal cord.

Neurological Institute

C. A. Elsberg and A. S. Taylor — Neurological surgery.

New York Hospital

C. L. Gibson, J. M. Hitzrot, C. E. Farr, S. Erdman, J. A. Vietor and E. M. Hawkes — General surgery.

Polyclinic Hospital

John A. Wyeth — Destruction of inoperable vascular neoplasms with hot water injections.

William Sharpe — Brain surgery.

Jerome M. Lynch — Carcinoma of rectum; suppurative colitis; reconstruction of colon of elbow deformity.

Presbyterian Hospital

A. V. S. Lambert — Stomach, gall-bladder, spinal cord and brain surgery.

E. T. Rulison — Appendix and hernia cases.

Hugh Auchincloss — Female mammary gland surgery.

A. O. Whipple — Gall-bladder surgery.

J. M. Hanford — Lymph glands and hernia surgery.

Forbes Hawkes — Uterus, appendix and hernia cases.

J. Bentley Squier and Joseph F. McCarthy — Bladder and kidney surgery.

Drs. Corscaden and Hanford — Demonstration of method of radiotherapy and exhibition of cases.

Drs. Lambert, Hawkes, Auchincloss, Carscaden, Whipple, Rulison and Hanford — Demonstration of methods of "follow-up" system.

W. C. Clarke and assistant — Surgical laboratory, demonstration of methods of keeping records and of "follow-up" system on malignant growths. Record room, demonstration, explanation of details of Columbia system of keeping records, terminology, filing system, unit history, binding of histories, "follow-up," interval results, etc.

Roosevelt Hospital

CHARLES H. PECK, SETH MILLIKEN, CHARLES N. DOWD and LUCIUS W. HOTCHKISS — General surgery.

Hospital for Ruptured and Crippled

WILLIAM B. COLEY and JOSEPH P. HOGUET — Radical cure of hernia.

Skin and Cancer Hospital

Operations and demonstrations of cases.

St. Francis Hospital

DRS. ROGERS, CRAMP, EDGERTSON and HARRIGAN — General surgery.

St. Luke's Hospital

WILLIAM A. DOWNES, WALTON MARTIN, NATHAN GREEN, FRANK S. MATHEWS, JOHN DOUGLAS and WINFIELD S. SCHLEY — General surgery.

St. Mary's Hospital

FRANK S. MATHEWS, EDWARD TRUESDELL and CHARLES E. FARR — General surgery.

St. Vincent's Hospital

JOSEPH B. BISSELL — Gall-bladder surgery.
ERNEST FAHNESTOCK — Acute surgery.
GEORGE D. STEWART — Gastric cases, duodenal ulcer cases.

GYNECOLOGY

Monday

HIRAM N. VINEBERG — Mount Sinai Hospital — 2.
JOSEPH BRETTAUER — Mount Sinai Hospital — 1:30.
FRANK R. OASTLER and EDWARD T. HULL — Lincoln Hospital — 3.
LEROY BROUN — Woman's Hospital — 2.
DOUGAL BISSELL — Woman's Hospital — 8:30.

Tuesday

EDWIN B. CRAGIN — Sloane Hospital — 3.
FRANK R. OASTLER — Lenox Hill Hospital — 9:30.
G. SEELIGMANN — Lenox Hill Hospital — 9.
HOWARD C. TAYLOR — Roosevelt Hospital — 9.
G. G. WARD, JR.— Woman's Hospital — 2.
HERMANN GRAD — Woman's Hospital — 8:30.
C. G. CHILD — Polyclinic Hospital — 9.
WILLIAM P. HEALY — Fordham Hospital — 9.
A. STEIN — Lenox Hospital — 2.
S. W. BANDLER — Post Graduate Hospital — 9.
G. SEELIGMANN — Lebanon Hospital — 9.

Wednesday

H. DAWSON FURNISS — Post-Graduate Hospital — 9.
I. S. HAYNES — Harlem Hospital — 2.
DOUGAL BISSELL — Woman's Hospital — 2.
WILLIAM P. HEALY — Roosevelt Hospital — 9.
A. STEIN — Harlem Hospital — 2.

Thursday

HIRAM N. VINEBERG — Mount Sinai Hospital — 2.
JOSEPH BRETTAUER — Mount Sinai Hospital — 1:30.
HOWARD C. TAYLOR — Roosevelt Hospital — 2:30.
I. S. HAYNES — Park Hospital — 2.
LEROY BROUN — Woman's Hospital — 2.
C. G. CHILD — Polyclinic Hospital — 9.
M. ROBINSON — Beth Israel Hospital — 2.
S. W. BANDLER — Beth Israel Hospital — 2.
G. SEELIGMANN — Lebanon Hospital — 2.

Friday

FRANK R. OASTLER — Lenox Hill Hospital — 2:30.
G. SEELIGMANN — Lenox Hill Hospital — 2.
G. G. WARD, JR.— Woman's Hospital — 2.
HERMANN GRAD — Woman's Hospital — 8:30.
S. W. BANDLER — Post Graduate Hospital — 9.

Days and hours to be announced

J. C. TAYLOR — Polyclinic Hospital.
T. H. MORGAN — Polyclinic Hospital.
L. J. LADINSKI — Polyclinic Hospital.
WILLIAM E. STUDDIFORD — Bellevue Hospital.
J. N. WEST — Post Graduate Hospital.
M. CATURANI — Italian Hospital.
H. S. STEARNS — City Hospital.
WALTER G. CRUMP — Hahnemann Hospital, New York Medical College for Women, Broad Street Hospital.

ORTHOPEDIC SURGERY

Monday

New York Orthopedic Hospital — 9, operations; 1:30, out-patient clinic.
Clinic for Functional Re-Education of Disabled Soldiers and Sailors — 10 to 4, out-patient clinic.
Hospital for Ruptured and Crippled — 1, operations; 1 to 3, out-patient clinic.
Bellevue Hospital — 3, out-patient clinic.
Post Graduate Hospital — 4:30, operations.
Hospital for Deformities and Joint Diseases — 2 to 3.

Tuesday

Hospital for Deformities and Joint Diseases — 8:30, operations; 2 to 3, out-patient clinic.
Hospital for Ruptured and Crippled — 9, operations; 1 to 3, out-patient clinic.
New York Orthopedic Hospital — 9, operations; 1:30, out-patient clinic.
Post Graduate Hospital — 9 and 4:30, operations.
Clinic for Functional Re-Education of Disabled Soldiers and Sailors — 10 to 4, out-patient clinic.
Bellevue Hospital — 2, out-patient clinic; 3, operations.
St. Luke's Hospital — 3:30, operations.

Wednesday

Hospital for Ruptured and Crippled — 9, operations; 1 to 3, out-patient clinic.
New York Orthopedic Hospital — 9, operations; 1:30, out-patient clinic.
Clinic for Functional Re-Education of Disabled Soldiers and Sailors — 10 to 4, out-patient clinic.
Hospital for Deformities and Joint Diseases — 2 to 3, out-patient clinic.
Bellevue Hospital — 3, out-patient clinic.
Post Graduate Hospital — 4:30, operations.

Thursday

New York Orthopedic Hospital — 9, operations; 1:30, out-patient clinic.
Hospital for Ruptured and Crippled — 9, operations; 1 to 3, out-patient clinic.

Hospital for Deformities and Joint Diseases — 8:30, operations; 2 to 3, out-patient clinic.
Bellevue Hospital — 2, out-patient clinic; 3, operations.
Clinic for Functional Re-Education of Disabled Soldiers and Sailors — 10 to 4, out-patient clinic.

Friday

Bellevue Hospital — 3, out-patient clinic.
Hospital for Deformities and Joint Diseases — 8:30 and 2 to 3, out-patient clinic.
New York Orthopedic Hospital — 9, operations; 1:30, out-patient clinic.
Clinic for Functional Re-Education of Disabled Soldiers and Sailors — 10 to 4, out-patient clinic.
Hospital for Ruptured and Crippled — 1 to 3.
St. Luke's Hospital — 3:30, operations.

UROLOGY

Monday

DRS. BUERGER, HYMAN and ACSHNER — Mt. Sinai Hospital — 1:30. Operations on kidney, ureter, bladder, and prostate. Demonstration of cases.
G. W. SWINBURNE and Assistants — Good Samaritan Hospital Dispensary — 10. Out-patient clinic.
DRS. ACKERMAN, ZAHLER, PANOF and FRIEDMAN — St. Mark's Hospital — 9. Out-patient clinic.
VICTOR C. PEDERSEN — St. Mark's Hospital — 11. Operations and demonstrations.
JOSEPH J. ASCH — Lenox Hill Hospital — 2. Demonstrations in general urology and cystoscopy.
FREDERIC BIERHOFF and L. L. MICHEL — West Side German Dispensary.
H. S. JACKS — Bellevue Hospital. Demonstration of pathological material and methods in urology.
B. S. BARRINGER — Bellveue Hospital — 2. Kidney and prostate operations.

Tuesday

DRS. BUERGER, HYMAN and ASCHNER — Mt. Sinai Hospital — 9. Operative cystoscopy. New method of treating filiform stricture of urethra through the universal urethroscope. Method of dilating ureter for descending ureteral calculi. Snaring of papillomata. Cytoscopic and urethroscopic diagnosis. Pathology of urological lesions and contraction of the neck of the bladder.
MAX HUEHNER — Mt. Sinai Hospital — 9. Demonstrations in diagnosis and care of sexual neurasthenia, pollutions, etc.; care of bladder tumors.
M. W. WARE — Mt. Sinai Hospital — 2. Operative clinic.
G. W. SWINBURNE and Assistants — Good Samaritan Hospital Dispensary — 10. Out-patient clinic.
DRS. ACKERMAN, ZAHLER, PANOF, and FRIEDMAN —; St. Mark's Hospital — 9. Out-patient clinic.
F. ACKERMAN — St. Mark's Hospital — 11. Operations.
H. G. BUGBEE and F. E. DUBOIS — Woman's Hospital — 10. Operations and demonstrations.
DRS. AYRES and CARLETON — Flower Hospital — 3. Bladder cases; operations and demonstrations.
OSWALD S. LOWSLEY — Bellevue Hospital — 2. Operations and demonstrations.
DRS. FURNISS, BULLARD, and PERILLI — Post Graduate Hospital — 2. Cystoscopic clinic.
MAXIMILIAN STERN — Broad Street Hospital — 2. Demonstrations of vesical neck obstructions and urethral strictures with new operating urethroscope. Hyperæmia treatment of urethral stricture. Operations.

Wednesday

DRS. BUERGER, HYMAN, and ASCHNER — Mt. Sinai Hospital — 9. Operative cystoscopy. New method of treating filiform stricture of urethra through the universal urethroscope. Method of dilating ureter for descending ureteral calculi. Snaring of papillomata. Cystoscopic and urethroscopic diagnosis. Pathology of urological lesions and contraction of the neck of the bladder.
LEO BUERGER — Polyclinic Hospital — 3:30. Operations on kidney and ureter.
G. W. SWINBURNE and Assistants — Good Samaritan Hospital Dispensary — 10. Out-patient clinic.
DRS. ACKERMAN, ZAHLER, PANOF, and FRIEDMAN — St. Mark's Hospital — 9. Out-patient clinic.
VICTOR C. PEDERSEN — St. Mark's Hospital — 11. Operations and demonstrations.
JOSEPH J. ASCH — Lenox Hill Hospital — 2. Demonstrations in general urology and cystoscopy.
H. G. BUGBEE and F. E. DUBOIS — St. Luke's Hospital — 10. Operations and demonstrations.
DRS. CARLETON and HALFMAN — Metropolitan Hospital — 3. Operative clinic.
FREDERIC BIERHOFF and L. L. MICHEL — West Side German Dispensary.
OSWALD S. LOWSLEY — New York Hospital — 10. Surgery and surgical pathology of the human prostate gland and seminal vesicles, demonstrated by lantern slides. Renal and ureteral lithiasis, demonstrated by specimens and lantern slides.
CHARLES J. GOELLER — New York Hospital — 10. Acute epididymitis; its treatment, surgical and non-surgical.
MAX S. ROLIDE — New York Hospital — 10. Gonorrhœal infection of the kidney; demonstration of two proved cases.
FRANK DEALEY — New York Hospital — 10. Pathological conditions of the bladder shown by cystoscopy.
B. S. BARRINGER — Memorial Hospital — 2. Radium treatment of carcinoma of bladder and prostate.
H. DAWSON FURNISS — Post Graduate Hospital — 9. Operative clinic (women).
EUGENE FULLER — City Hospital — 2. Operative clinic.

Thursday

DRS. BUERGER, HYMAN, and ASCHNER — Mt. Sinai Hospital — 1:30. Operations on kidney, bladder and prostate. Demonstration of cases.
MAX HUEHNER — Mt. Sinai Hospital — 9. Demonstrations in diagnosis and care of sexual neurasthenia, pollutions, etc.; care of bladder tumors.
G. W. SWINBURNE and Assistants — Good Samaritan Hospital Dispensary — 10. Out-patient clinic.
DRS. ACKERMAN, ZAHLER, PANOF, and FRIEDMAN — St. Mark's Hospital — 9. Out-patient clinic.
H. G. BUGBEE and F. E. DUBOIS — Woman's Hospital — 10. Operations and demonstrations.
OSWALD S. LOWSLEY — Bellevue Hospital — 2. Lesions of the external genitalia; exhibition of patients and lantern slide demonstrations. Malignant growths of urological organs, demonstration of postoperative patients.
MAXIMILIAN STERN — Broad Street Hospital — 2. Demonstrations of vesical neck obstructions and urethral strictures with new operating urethroscope. Hyperæmia treatment of urethral stricture. Operative clinic.

DRS. FURNISS, BULLARD and PERILLI — Post Graduate Hospital — 9. Cystoscopic clinic.

Friday

G. W. SWINBURNE and Assistants — Good Samaritan Hospital Dispensary — 10. Out-patient clinic.

DRS. ACKERMAN, ZAHLER, PANOF, and FRIEDMAN — St. Mark's Hospital — 9. Out-patient clinic.

F. ACKERMAN — St. Mark's Hospital — 11. Operations.

VICTOR C. PEDERSEN — St. Mark's Hospital — 11. Operations and demonstrations.

JOSEPH J. ASCH — Lenox Hill Hospital — 2. Demonstrations in general urology and cystoscopy.

M. W. WARE — Mt. Sinai Hospital — 9. General clinic.

H. G. BUGBEE and F. E. DUBOIS — St. Luke's Hospital — 10. Operations and demonstrations.

FREDERIC BIERHOFF and L. L. MICHEL — West Side German Dispensary.

OSWALD S. LOWSLEY — Bellevue Hospital — 2. Operations and demonstrations.

Days and hours to be announced

A. L. WOLBARST — Beth Israel Hospital — Vasopuncture. Litholapaxy. Catheterization of ejaculatory canals. Epididymo-vasostomy (Martin). Cystoscopic and urethroscopic demonstrations.

EUGENE FULLER — Post Graduate Hospital — Seminal vesiculotomy.

PATHOLOGY

J. R. LOSEE — Lying-in Hospital — Daily, 9 to 5. Museum specimens of obstetrical and prenatal pathology.

DR. STRONG — Woman's Hospital — Daily.

D. SYMMERS and A. V. ST. GEORGE — Bellevue Hospital — Thursday, 11. Anatomical and histological preparation of surgical specimens.

J. E. MCWHORTER — Bellevue Hospital — Monday, 11, Experimental observations on the healing of wounds. with lantern demonstration.

S. S. DIXON — New York Eye and Ear Infirmary — Monday and Wednesday, 10. Exhibition of macroscopical eye specimens.

OPHTHALMOLOGY

Monday

DR. DIXON — New York Eye and Ear Hospital — 11 X-ray localization for foreign body in eye and orbit.

DR. REESE — New York Eye and Ear Hospital — 2. Ptosis, modified Machek. Resection for convergent and divergent strabismus. Extirpation lacrymal sac. Cataract extraction, La Grange operation.

DR. SHANNON — Manhattan Eye and Ear Hospital — 2. Elliot trephining, cataract extraction (combined).

DR. CASSELL — Manhattan Eye and Ear Hospital — 2. Cataract extraction, Kalt suture. Iridectomy.

DR. ALGER — Post Graduate Hospital — 2. Cataract extraction. Advancement operation.

Tuesday

DR. BELL — New York Eye and Ear Hospital — 2. Cataract extraction. Modified LaGrange for glaucoma.

DR. E. THOMSON — Manhattan Eye and Ear Hospital — 2. Cataract extraction. Trephine for retinal detachment.

DR. KNAPP — Knapp Memorial Eye Hospital — 2. Intracapsular cataract extractions and operative clinic.

DR. SHEPHARD — New York Ophthalmic Hospital — 10. Stereoscopic exercises; training in binocular vision.

DR. HEALY — New York Ophthalmic Hospital — 11. Ophthalmoscopic clinic.

DR. MCLANE — New York Ophthalmic Hospital — 2. Monometric readings with aid of McLane's tonometer in human eyes.

DR. M. COHEN — Post Graduate Hospital — 2. Heisrath-Kuhnt operation for trachoma. Extirpation lacrymal sac.

DR. CUTLER — St. Luke's Hospital — 2. Ophthalmoscopic clinic.

DR. NOGUCHI — Rockefeller Institute — 11. Demonstration of specimens of bacteria in conjunctival diseases.

Wednesday

DR. DIXON — New York Eye and Ear Hospital — 11. X-ray localization of foreign body in eye and orbit. Exhibition of pathological eye specimens.

DR. LAMBERT — New York Eye and Ear Hospital — 2 Operation for congenital dislocation of lens and needing for high myopia.

DR. HELFRICH — New York Ophthalmic Hospital — 11. Ophthalmoscopic clinic.

DR. LLOYD — New York Ophthalmic Hospital — 11. Demonstration with lantern slides of campimeter. Cataract extraction, Smith method, intracapsular.

DR. HALLETT — New York Ophthalmic Hospital — 2. Intracapsular cataract extraction.

DR. DAVIS — Post Graduate Hospital — 2. Cataract extraction. Advancement operation.

DR. WIENER — St. Luke's Hospital — 2. Dacryo-cystorhinostomy, external method.

DR. KOLLER — Mt. Sinai Hospital — 2. Cataract extraction. Hotz's operation for glaucoma.

Thursday

DR. WEEKS — New York Eye and Ear Hospital — 2. Cataract extraction (La Grange). Lid plastic.

DR. WHEELER — New York Eye and Ear Hospital — 2. Cataract extraction. Extirpation of lacrymal sac.

DR. THOMSON — Manhattan Eye and Ear Hospital — 2. Cataract extraction. Elliot trephining.

DR. VAN FLEET — Manhattan Eye and Ear Hospital — 2. Cataract extraction. Advancement.

DR. KENNY — Manhattan Eye and Ear Hospital — 2. Cataract extraction.

DR. TYSON — Knapp Memorial Eye Hospital — 2. Cataract extraction. Ophthalmological clinic.

DR. TOROK — Knapp Memorial Eye Hospital — 2. Intracapsular cataract extraction. Lacrymal sac. Mueller's operation for retinal detachment.

DR. TRONCOSO — Post Graduate Hospital — 2.

DR. MEDING — Harlem Eye and Ear Hospital — 2. Intracapsular cataract extraction, Smith method. Elliot trephining for glaucoma.

Friday

DR. CALLAN — New York Eye and Ear Hospital — 2. Capsular cataract (DeWecker). Elliot trephining. Motais operation for ptosis.

DR. LAMBERT — New York Eye and Ear Hospital — 2. Ophthalmological clinic.

DR. MITTENDORF — Manhattan Eye and Ear Hospital — 2. Cataract extraction, Homer Smith method. Advancement. Enucleation with fat transplantation.

DR. HARE — Manhattan Eye and Ear Hospital — 2. Graduate tenotomy.

DR. WOOTTON — Manhattan Eye and Ear Hospital — 2 Ophthalmological clinic.

DR. MEEKER — Post Graduate Hospital — 2. Demonstration of pathological eye specimens.

DR. MAY — Bellevue Hospital — 2. Cataract extraction. Advancement, Lancaster method.

DR. WOLFF — Bellevue Hospital — 2. Enucleation with fat transplantation. Hotz operation for glaucoma.

LARYNGOLOGY

Monday

L. A. COFFIN — Manhattan Eye, Ear, and Throat Hospital — 2:30. Intranasal exenteration of ethmoidal cells with simultaneous cadaver demonstration.

A. M. ANDERSON — Polyclinic Hospital — 2. Frontal sinus and antral operation, intranasal; radiographic plates, demonstrating results after operation.

E. L. PRATT — Bellevue Hospital — 2. Submucous nasal resection. Exhibition of cases.

JOHN MCCOY — University and Bellevue Hospital Medical School — 2. Tonsillectomy and submucous nasal resection.

L. M. HURD — New York Throat and Nose Hospital — 2:30. Tonsillectomy and submucous resection.

JOHN LESHURE — Vanderbilt Clinic — 2. Tonsillectomy.

J. B. FERGUSON and J. L. MAYBAUM — Post Graduate Hospital — 12:30. Tonsillectomies, snare, Sluder and Beck-Muller methods.

Tuesday

H. L. LYNAH — Willard Parker Hospital — 9. Demonstration of direct intubation and extubation. Laryngeal cauterization for chronic stenosis of larynx. Bronchoscopy for removal of diphtheritic foreign body obstruction.

JOHN E. MACKENTY — Manhattan Eye, Ear, and Throat Hospital — 11. Laryngectomy.

E. R. FAULKER — Manhattan Eye, Ear, and Throat Hospital — 9.30. Intranasal exenteration of ethmoidal cells under general anæsthesia.

J. J. KING — New York Eye and Ear Infirmary — 9:30. Tonsillectomy.

JOHN M. HALL — New York Eye and Ear Infirmary — 9:30. Tonsillectomy, cocaine anæsthesia.

L. M. HURD — Bellevue Hospital — 11. Intranasal operations on the nasal accessory sinuses.

J. D. KERNAN, JR.— Bellevue Hospital — 2:30. Nasal operations under local anæsthesia. Exhibition of cases.

J. E. MACKENTY — Manhattan Eye, Ear, and Throat Hospital — 3. Bone transplantation for nasal deformity.

J. H. ABRAHAM — Polyclinic Hospital — 2. Demonstration of nasal accessory sinus cases, with radiographic plates.

E. L. PRATT — Vanderbilt Clinic — 2. Tonsillectomy.

ARTHUR J. HUEY — University and Bellevue Hospital Medical College — 2. Submucous nasal resection.

W. W. CARTER — Gouverneur Hospital — 2. Bone transplantation for correction of nasal deformity.

B. DOUGLASS — Post Graduate Hospital — 12:30. Submucous resection of septum. Tonsillectomy by various methods. Nasal sinus surgery.

Wednesday

H. L. LYNAH — Polyclinic Hospital — 9. Demonstration of direct laryngoscopy and œsophagoscopy.

LEWIS A. COFFIN — Manhattan Eye, Ear, and Throat Hospital — 11. Operation for relief of ozena and presentation of cases.

N. R. DANN — New York Eye and Ear Infirmary — 9:30. Radical accessory nasal sinus operations.

C. G. COAKLEY — Bellevue Hospital — 2:30. External nasal accessory sinus operation.

J. D. KERNAN, JR.— Manhattan Eye, Ear, and Throat Hospital — 2. Operation for nasal deformity.

O. L. MONROE — Manhattan Eye, Ear, and Throat Hospital — 2. Tonsillectomy, local anæsthesia.

W. W. GRIFFIN — Manhattan Eye, Ear, and Throat Hospital — 2. Submucous nasal resection.

DRS. A. P. VOISLAWSKY, L. T. PERRAULT, and W. M. HUNT — St. Luke's Hospital — 2. Tonsillectomy, St. Luke's method, general and local anæsthesia, in cardiac and rheumatic patients in whom tonsil is focus of infection.

D. B. DELEVAN — St. Luke's Hospital — 2. Laryngectomy; end-results. Use of Dichloramine-T. Chlorcosane solution as used for disinfection of "carriers."

H. L. LYNAH — Polyclinic Hospital — 2. Bronchoscopy for thymic tracheal stenosis.

H. L. GATEWOOD — Polyclinic Hospital — 2:30. Tonsillectomy; new method of local anæsthesia.

M. D. LEDERMAN — Polyclinic Hospital — 3:30. Demonstration and treatment of lingual tonsil.

W. W. CARTER — Radium Sanatorium — 2. Bridge splint operation for correction of nasal deformity.

C. A. FRELIGH — Post Graduate Hospital — 12:30. Tonsillectomy. Submucous resection of septum.

Thursday

H. L. LYNAH — Willard Parker Hospital — 9. Demonstration of direct laryngoscopy, bronchoscopy, and œsophagoscopy; direct and digital method of intubation. Trachelotomy cases.

JOHN MCCOY — New York Eye and Ear Infirmary — 9:30. Laryngeal and nasal accessory sinus operations.

D. S. DOUGHERTY — Polyclinic Hospital — 10. Suspension laryngoscopy.

J. D. KERNAN, JR.— Bellevue Hospital — 2:30. Laryngostomy, tracheal stenosis. Suspension laryngoscopy.

J. E. MACKENTY — Manhattan Eye, Ear, and Throat Hospital — 2. Cleft palate operation.

J. A. MULHOLLAND — Manhattan Eye, Ear, and Throat Hospital — 2. Intranasal operation, nasal accessory sinuses.

WILLIAM M. DUNNING — Manhattan Eye, Ear, and Throat Hospital — 3. Submucous resection of nasal septum.

A. M. ANDERSON — Polyclinic Hospital — 2. Exhibition of sinus cases.

W. W. CARTER — Gouverneur Hospital — 2. Nose and throat operations.

B. DOUGLASS — Post Graduate Hospital — 12:30. Tonsillectomy under local anæsthesia. Bronchoscopy and œsophagoscopy.

Friday

E. V. HUBBARD — Manhattan Eye, Ear, and Throat Hospital — 11. Partial thyroidectomy (for goiter) with transplantation of remaining tube.

T. L. SAUNDERS — New York Eye and Ear Infirmary — 9:30. Radical nasal accessory sinus operation.

L. D. ALEXANDER — New York Eye and Ear Infirmary — 9:30. Intranasal antrum operation, cocaine anæsthesia.

L. M. HURD — Bellevue Hospital — 2:30. External accessory nasal sinus operation.

J. H. ABRAHAM — Polyclinic Hospital — 2. Tonsillectomy and method of ligation.

HARMON SMITH — Manhattan Eye, Ear, and Throat Hospital — 2. Tonsillectomy (Sluder).

I. W. VOORHEES — Manhattan Eye, Ear, and Throat Hospital — 2. Demonstration of the use of Dichloramine-T in infection of respiratory tract.

LEWIS A. COFFIN — Manhattan Eye, Ear, and Throat Hospital — 2:30. Nasal accessory sinus operations.

J. B. FERGUSON and J. L. MAYBAUM — Post Graduate Hospital — 12:30. Nasal sinus surgery, intranasal. Larynx examination, direct and indirect.

OTOLOGY

Monday

W. C. BOWERS — Bellevue Hospital — 2:30. Radical mastoid with skin grafting.

DR. KERRISON — Manhattan Eye, Ear and Throat Hospital — 2. Operative clinic.

DR. RICHARDS — Manhattan Eye, Ear and Throat Hospital — 3. Operative clinic.

DR. DWYER — Manhattan Eye, Ear and Throat Hospital — 2. Laboratory demonstration.

DRS. DENCH, PERKINS, ROBINSON and SCUTTER — New York Eye and Ear Infirmary — 2:30. Operations and demonstration of cases.

DR. SCHOOMAKER — Post Graduate Hospital — 2:30. Mastoid.

Tuesday

T. L. SAUNDERS — Bellevue Hospital — 2:30. Acute mastoid operation.

DR. PIKE — Manhattan Eye, Ear and Throat Hospital — 10. Experimental demonstration: Effect of certain lesions of the central nervous system on nystagmus.

DR. PHILLIPS — Manhattan Eye, Ear and Throat Hospital — 2. Operative clinic.

DR. SHARP — Manhattan Eye, Ear and Throat Hospital — 3 Operative clinic.

DR. LAW — Manhattan Eye, Ear and Throat Hospital — 3. Demonstration of cases.

DRS. DENCH, PERKINS, ROBINSON and SCUTTER — New York Eye and Ear Infirmary — 10:30. Operations and demonstrations.

DR. DIXON — New York Eye and Ear Infirmary — 10:30. Demonstration: Radiographs of mastoid cases.

DRS. BACON, SUTPHEN, and HALL — New York Eye and Ear Infirmary — 2:30. Operations and demonstrations of cases.

DR. MCFARLAND — Post Graduate Hospital — 2:30. Radical mastoid operation.

Wednesday

DR. SMITH — Polyclinic Hospital — 10. Demonstration on cadaver of radical and labyrinth operations.

DR. STEVENS — Polyclinic Hospital — 2. Radical operation.

DRS. FRIESNER and STRAUS — Manhattan Eye, Ear, and Throat Hospital — 10. Demonstration of neurological cases showing abnormalities of nystagmus.

DR. KERRISON — Manhattan Eye, Ear and Throat Hospital — 2. Operative clinic.

DR. PHILLIPS — Manhattan Eye, Ear and Throat Hospital — 3. Cinematographic demonstration of mastoid operation.

DR. WHITING — New York Eye and Ear Infirmary — 2:30. Operations and demonstrations.

DRS. LEWIS, BLACKWELL, FERGUSON and KING — New York Eye and Ear Infirmary — 2:30. Operations and demonstrations.

DR. FARR — Post Graduate Hospital — 2:30. Mastoid operation.

Thursday

DR. DENCH — St. Luke's Hospital — 2:30. Radical operation for chronic middle ear suppuration.

DR. BOWERS — St. Luke's Hospital — 2:30. Complete mastoid operation.

DR. PERKINS — St. Luke's Hospital — 10. Ward demonstration.

DR. DWYER — Manhattan Eye, Ear and Throat Hospital — 10. Laboratory demonstration.

DR. BRAUN — Manhattan Eye, Ear and Throat Hospital — 2. Operative clinic.

DRS. DWYER and FRIESNER — Manhattan Eye, Ear and Throat Hospital — 3:30. Demonstration: Radical mastoid operation on cadaver.

DRS. LEWIS, BLACKWELL, FERGUSON, and KING — New York Eye and Ear Infirmary — 10:30. Otorhinological clinic.

DR. DIXON — New York Eye and Ear Infirmary — 10:30. Demonstration: Radiographs of the mastoid.

DR. MCCOY — New York Eye and Ear Infirmary — 2:30. Operations and demonstrations.

DR. O'CONNELL — Post Graduate Hospital — 2:30. Radical mastoid operation.

Friday

DR. DAVIS — Polyclinic Hospital — 10. Demonstration of labyrinth tests.

DR. SMITH — Polyclinic Hospital — 2. Demonstration of ten postoperative mastoid (radical) cases.

DR. HURD — Bellevue Hospital — 2:30.

DR. LAW — Manhattan Eye, Ear and Throat Hospital — 10. Lantern slide demonstration of X-rays of mastoid and sinus.

DR. MCFARLAND — Manhattan Eye, Ear, and Throat Hospital — 2. Operative clinic.

DR. PAGE — Manhattan Eye, Ear, and Throat Hospital — 3:30. Operative clinic.

DRS. SAUNDERS and A. U. CALLISEN — New York Eye and Ear Infirmary — 2:30. Operations and demonstrations.

DR. SMITH — Post Graduate Hospital — 2:30. Mastoid demonstration.

DR. BROWN — Post Graduate Hospital — 3:30. Cochlear and vestibular tests in connection with malingering.

PRELIMINARY SCHEDULE OF CLINICS IN BROOKLYN

GENERAL SURGERY, ORTHOPEDICS AND UROLOGY

Monday

R. S. FOWLER and A. H. BOGART — Methodist Episcopal Hospital — 9.
W. F. CAMPBELL (or J. S. WIGHT) — Long Island College Hospital — 9.
J. M. DOWNEY — Holy Family Hospital — 9:30.
WILLIAM and JOHN LINDER — Jewish Hospital — 9.
J. B. BOGART and G. I. MILLER — Jewish Hospital — 2.
H. C. FETT — Long Island College Hospital — 8.
N. P. RATHBURN — Brooklyn Hospital — 9.

Tuesday

R. W. WESTBROOK and H. F. MCCHESNEY — Brooklyn Hospital — 9.
W. PASCUAL — Holy Family Hospital — 9:30.
J. B. BOGART — Kings County Hospital — 9.
H. F. GRAHAM and C. H. GOODRICH — Methodist Episcopal Hospital — 9.
W. TRUSLOW — Brooklyn Hospital — 2.
H. E. FRASER — Kings County Hospital — 2.

Wednesday

W. F. CAMPBELL — Long Island College Hospital — 2.
R. S. FOWLER and G. H. BOGART — Methodist Episcopal Hospital — 9.
WILLIAM and JOHN LINDER — Jewish Hospital — 9.
J. M. DOWNEY — Holy Family Hospital — 9:30.
J. B. BOGART and G. I. MILLER — Jewish Hospital — 2.
N. P. RATHBURN — Brooklyn Hospital — 9.

Thursday

R. W. WESTBROOK and H. F. MCCHESNEY — Brooklyn Hospital — 9.
J. B. BOGART — Kings County Hospital — 9.
H. F. GRAHAM and C. H. GOODRICH — Methodist Episcopal Hospital — 9.
H. H. MORTON — Long Island College Hospital — 3.

Friday

R. S. FOWLER and A. H. BOGART — Methodist Episcopal Hospital — 9.
WILLIAM and JOHN LINDER — Jewish Hospital — 9.
J. B. BOGART and G. I. MILLER — Jewish Hospital — 2.
J. S. WIGHT — Long Island College Hospital — 9.
H. C. FETT — Long Island College Hospital — 8.
N. P. RATHBURN — Brooklyn Hospital — 9.

GYNECOLOGY

Monday

C. A. GORDON — St. Catherine's Hospital — 8:30.

Tuesday

C. S. HYDE and W. P. POOL — Long Island College Hospital — 8.
H. A. WADE — Bethany Deaconess Hospital — 10.
V. A. ROBERTSON — Coney Island Hospital — 9.
V. L. ZIMMERMAN — Holy Family Hospital — 9.
A. M. JUDD and A. BONNER — Jewish Hospital — 9.
V. L. ZIMMERMAN — St. Mary's Hospital — 9.
O. P. HUMPSTONE — Methodist Episcopal Hospital — 9.
J. P. GLYNN — Williamsburg Hospital — 9.
J. O. POLAK and L. SCHWARTZ — Jewish Hospital — 2.

Wednesday

L. G. BALDWIN — Skene Sanitarium — 8:30.
R. M. BEACH — Methodist Episcopal Hospital — 9.
R. H. POMEROY — Brooklyn Hospital — 9.
F. WEISBROD — German Hospital — 8.
W. A. JEWETT — Bushwick Hospital — 9.
H. A. WADE — Williamsburg Hospital — 10.

Thursday

V. A. ROBERTSON — Coney Island Hospital — 9.
F. C. HOLDEN — Greenpoint Hospital — 9 and 2.
V. L. ZIMMERMAN — Holy Family Hospital — 9.
J. P. GLYNN — Williamsburg Hospital — 9.
C. A. GORDON — St. Catherine's Hospital — 8:30.
V. L. ZIMMERMAN — St. Mary's Hospital — 9.
J. O. POLAK and L. SCHWARTZ — Jewish Hospital — 2.
O. P. HUMPSTONE — Methodist Episcopal Hospital — 9.
A. BONNER — Jewish Hospital — 9.
J. O. POLAK — Long Island College Hospital — 8.

Friday

R. H. POMEROY — Brooklyn Hospital — 9.
W. A. JEWETT — Bushwick Hospital — 9.
S. J. MCNAMARA — Kings County Hospital — 9.
L. G. BALDWIN — Skene Sanitarium — 8:30.

SURGERY OF THE EYE, EAR, NOSE AND THROAT

Monday

C. G. CRANE and W. S. SHATTUCK — Brooklyn Hospital — 9. Ear, nose and throat.
P. H. STURGIS — Methodist Episcopal Hospital — 2. Nose and throat.

Tuesday

A. M. HOWE and A. HAYMAN — Jewish Hospital — 2. Ear, nose and throat.
A. J. KEENAN — Long Island College Hospital. Nose and throat.
H. M. SMITH — Long Island College Hospital. Eye.

Wednesday

P. H. STURGIS — Methodist Episcopal Hospital — 2. Nose and throat.

Thursday

C. G. CRANE and W. S. SHATTUCK — Brooklyn Hospital — 2. Nose and throat.

Friday

P. H. STURGIS — Methodist Episcopal Hospital — 2. Nose and throat.
A. M. HOWE and A. HAYMAN — Jewish Hospital — 2. Nose and throat.